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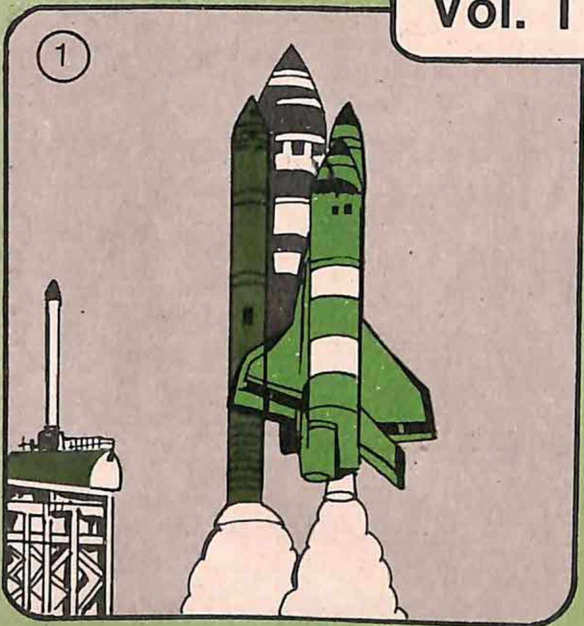
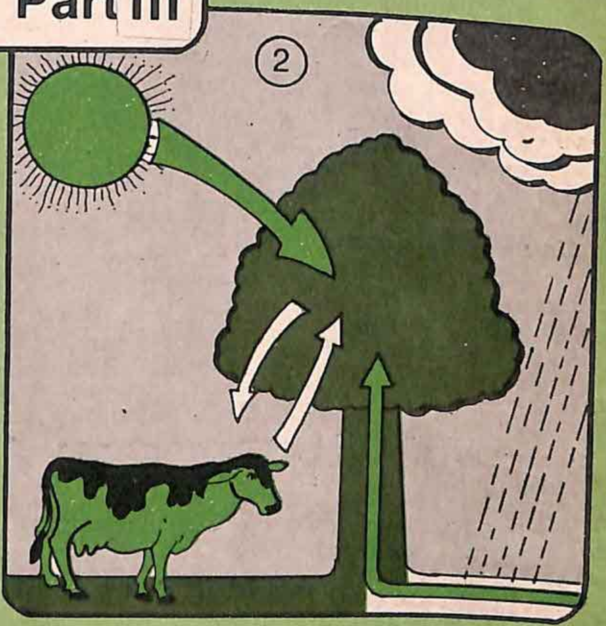
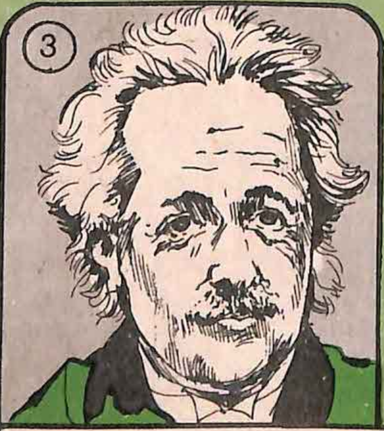
Vol. I Part III







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FUNDAMENTALS
OF
SCIENCE

Vol. I Part III

(For Class IX)

(Covering Units 3, 4 and 5 Ways of Living, Human Beings and World of Work)

By
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Syllabus Prescribed by CBSE for Class IX

Unit 3: Ways of Living

Habitat and Organisms: Habitat, types of habitat; classification of organisms based on habitats, habitats and organisms, interdependence, alteration of habitats and its effects on organisms including man, conservation of habitats.

Adaptation: Structural and functional potentialities of organisms, structural adaptation with reference to internal and external factors. Functional adaptation refers to life processors.

Organisation of Living World: Different levels of organization—organisms, cellular and molecular. Structure and function of cell, difference between plant and animal cells, cell division, mitosis and meiosis.

Life Processes: Nutrition, photosynthesis autographs, Heterotrophs, Respiration, Internal transport, Excretion, Reproduction, Growth and differentiation, Control and Co-ordination.

Study of Birds: habits and behaviour of familiar birds.

Unit 4 : Human Beings

Evolution of human beings: Ancestral forms, Hominids, Fossil remains of Neanderthal man, Peking man, Coromagnon man, continuous efforts of man to reshape the natural environment. Necessity and inventions.

Uniqueness of human body; Organisation of human body; Unique organs of the human body—Biped and erect posture, opposite thumb, highly developed brain, location of eye, colour sensitive retina, presence of salivary amylase, antigravity postural muscles, location of testes.

Capability of year round reproduction, some characteristics of human body common to other animals.

Structural limitations of human body : Instability due to bipedal and erect posture, loss of tail, loss of hair, vision in relation to wavelength, less developed olfactory organ. Limitation to hearing, immovable and short pinna, canine teeth, short intestine, loss of claws, less number of red muscles, structural limitation of human body common to other animals. Manipulation of environment to overcome limitations, for physical, biological and cultural needs.

Regulation of environment : use and exploration of needs, control and use of fire regulation of micro and macro levels, Advantages and disadvantages of regulation.

Unit 5: World of Work

Man and work—variety in nature of work, work involved in procuring, processing and preparation of food by man and other living organisms, energy required for doing work, motion as manifestation of work.

Technology—meaning and applications; evolution of technology and human society: development of new and improved technology need, acceptance by the society, time gap between development and application; role of technology in harnessing energy.

Impact of technology on society—influence of technology on individual needs, energy requirements of the individual and the society, energy crisis, impact of technology on physical, social and cultural environment. Technology and Science—Interrelation between science and technology, application of technology in development of science; one technology creates need for another.

PREFACE

This volume covers Units 3, 4 and 5 of the Science syllabus for Class IX prescribed by the Central Board of Secondary Education, New Delhi for the Secondary School Examination under the Delhi and All India Schemes.

The contents of the three units viz., Unit-3 (The Ways of Living), Unit-4 (Human Beings) and Unit-5 (World of Work) are further divided into chapters to make the study of the subject systematic and easy to follow. The book contains the latest information on each topic. Each concept has been explained lucidly and illustrated with diagrams wherever possible. The language is easy to understand.

Learning objectives have been given in the beginning of each chapter. *Summary* of each chapter has been given at the end of the text for quick revision.

At the end of each chapter questions are also given which are varied in nature like *definition forms*, *objective type questions*, *fill in the blanks*, *short answer* and *essay type questions*. All the questions bear a direct relevance to the subject matter of the chapter.

I hope the book will prove useful for the students.

Suggestions for the improvement of the book will be gratefully received and acknowledged.

April, 1991

R.G. VARSHNEY

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UNIT III

WAYS OF LIVING

CHAPTER 1

HABITATS—LIVING PLACES AND ORGANISMS

LEARNING OBJECTIVES

At the completion of this Chapter, you should be able to grasp :

1. The meaning of the habitat, microhabitat, environment and its biotic and abiotic components.
2. The meaning of host and parasites and their interdependence. The meaning of ectoparasites and endoparasites with their examples.
3. Types of habitats — hydrophytes, mesophytes and xerophytes—their special characters with examples.
4. Ecological habitats in animals—hydrozoic and terrestrial.
5. Terrestrial animals are further grouped on the basis of their adaptations like Arborial adaptation, Xerophytic adaptation, Polar region adaptation and Amphibious adaptation.
6. Need of adaptation.
7. You can explain the theory of Charls Darwin—survival of the fittest and Natural selection with the help of examples.

INTRODUCTION

The word 'Biology' is derived from Latin language. It is synthesised by two words — 'Bios' which means 'the living beings' and 'logus' which means 'to study with'. Thus Biology means 'to study about the living beings'. The study about living beings does not concern only about the external and internal structures and functions of the body organs but also about the relation of living beings with the surroundings. The place where any living organism is found, must suit to it otherwise it will die. Any living being is not only closely related to the abiotic factors of the surroundings like, air, water, soil, temperature and other climatic factors but is also closely affected by the other living organisms, living nearby.

Thus we can say that all living beings are interdependent. This interdependence is due to food, shelter and to fulfil other biological needs. A study of these interaction between the organisms and their conditions of living places gives us an important lesson about the earth, environment and Biosphere. The environment is basically divided into two components — (1) The living organisms which include all types of plants and all types of animals and (2) the non-living components like air, water, soil, temperature, light etc. Every living being lives by adjusting itself in both the components of the environment.

The study of the environment is given a term 'Ecology' which can be defined as "Ecology is a branch of Biology which deals with the study of living organisms with respect to their environment."

1.1 THE HABITAT

Though the whole environment is extended upto about 13 kilometres but 6 kilometres above from earth and 7 kilometres deep inside the earth makes a belt in which the living organisms live. So this belt is called as 'Biosphere', you know that one type of living organisms are not found at one place. You will find several types of living organisms living at one place. Now the question arises that why several types but specified species are found living at one place ?

You can simply answer that the environmental conditions of that place might be suited to them for their existence. This phenomenon is called 'The Habitat'. Thus Habitat can be defined as *The habitat of an organism is the place where it lives or dwells for food, shelter and other biological needs*. The climatic conditions must be suited to the organism where it can survive, breed and can do all the vital activities easily like respiration, excretion, locomotion, etc. The habitat of an organisms is a part of the total environment of the region. For instance the habitat of monkeys in the forests of Sri Lanka, Malaya, South India, Burma, Thailand, Singapore etc. It means the total environment of the forests of tropical countries which includes not only the climate of the forests but also woods and plants and other animals living in those forests. Thus a habitat includes both.

1. Physical or abiotic components like temperature, rainfall, sun-light and other seasons and climate, and
2. Biotic components like other animals and plants. The habitat indicates towards the place and other situations available to that organisms but the behaviour of that organism towards other biotic components of that place is also seen which is termed as 'Ecological Niche'. *Ecological Niche reveals the role of the organism in the surrounding. It may be called as the profession of that particular organism in the environment.*

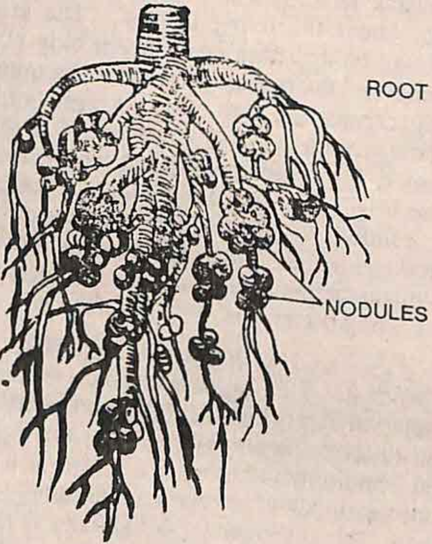
1.2 MICRO HABITAT

As the monkeys are found in all the tropical countries but all the conditions of all the countries will not be similar. So the species of monkeys found in various countries will be different. In the same way in India the climate of different states is different. So one type of animal or plant can be found all over the country but their species or families or classes will be different. For example the rats, such as common field rats are terrestrial and are generally found in U.P., Bihar, M.P., Andhra Pradesh and other similar areas. Their behaviour and habits will be similar. Their size, body colour and breeding places will be identical. You will find field rats in Rajasthan also. Their habits and behaviour are totally different with that of the previous type field rats. They are similar in size but prefer to come out only in the night, burrows deep in the ground and do not require much water. Such differentiation is termed as 'Micro habitat'. *This term is used in reference to an area which is not based on the size of population.* Many plants like Acacia arabica (Babool), Cactus etc., are commonly found in Rajasthan but are seen rarely in other states — due to the difference in the climate, soil, availability of water, wind etc.

1.3 INTERDEPENDENCE

No one can live alone. One organism is dependent on other organisms for food and other Biological needs. Animals depend on other animals while animals depend on plants too. This phenomenon is called as Interdependence or Mutualism. In this interdependence both the organisms are benefited. For instance, ostriches accompany with Zebra in Africa. Ostriches act a the watchmen for Zebra and get their food for thei service. In the same way the egret bird sits on the buffalo all the time, takes rest and eats the lice, ticks and other insects deeply connected with the skin of buffalo. On the other hand the buffalo is also benefited as it is freed from the insects, ticks, lice etc., and the wounds are healed up quickly. These egret birds are called as the **Ectoparasites** while the buffalo is called as the *host* but this *phenomenon in which two animals living together and both are benefited to each other is called Commensalism.* Ascaris, Tapeworm, etc., are found in the alimentary canal of mammals. They get their food and also shelter from the mammals. So they are called as **Endoparasites** while the mammal is called as the host. Here in this example only the parasites are benefited but the host is at loss. Lice, bedbug, leech, mosquitoes etc., are Ectoparasites. They get their food from the host but host is not benefited in any way.

Another example of interdependence is of Rhizobium bacteria and the leguminous plants. Rhizobium bacteria are nitrifying bacteria which receive the nitrogen from the atmosphere and convert it into nitrates and nitrites and give it to the plant. They live in the nodules (the knot like swollen parts) of the roots of the leguminous plants as shown in Fig. 1·1.



Roots of the Leguminous
Fig. 1·1

They take various food elements in the form of prepared food material and the shelter. Thus bacteria and the plant both are benefited to each other. The phenomenon is called as Symbiosis. It can be defined as Symbiosis is the process of living of two plants together in such a way that both are benefited to each other."

1.4 TYPES OF HABITATS

As you are already aware that Biosphere is 13 kilometres belt which includes air, water and earth. So the whole biosphere is divided into three main types of Habitats — (1) The water habitat (**Hydrosphere**); (2) The soil habitat (**Lithosphere**); and (3) The air habitat (**Atmosphere**). In all the three types of habitats plants and animals live together but the biotic components of one habitat is totally different from the biotic components of other habitat. Therefore all the habitats will be studied separately.

1.5 CLASSIFICATION OF ORGANISMS BASED ON HABITATS :

1. PLANT HABITATS :

Plants are found in hydrosphere, lithosphere and atmosphere. No doubt, all are plants and have the common body parts but their shape, size, behaviour and functions all are different due to the variation in abiotic components available there (Table *1.1*). So the plant habitats are studied separately into the following groups :

Hydrophytic plants (Hydrophytes) : *The plants which are found in water or in swampy places are called as Hydrophytes. (See Fig 1.2).* They have the following main characters :

(*i*) They may be submerged or partly submerged, floating or amphibious.

Table 1.1 Comparative Characteristics of Hydrophytes, Mesophytes & Xerophytes

Hydrophytes	Mesophytes	Xerophytes
Morphological		
1. Roots are greatly reduced, even absent. If present unbranched without root-hairs.	Root system well developed tap or fibrous roots with root-hairs.	Root system deep, extensive, reaching deeper layer of soil.
2. Stem very much reduced, thin and delicate.	Stem is rigid and stout.	Stem much dwarfed, branched, sometimes underground.
3. Leaves thin, linear, some with long petiole and large lamina covered with wax.	Leaves large, generally without waxy covering.	Leaves small, sometimes reduced to scales or modified in spines. In some large with waxy coating, or hairs on the surface.
Anatomical		
1. Cuticle generally absent	Cuticle developed.	Cuticle thick and well developed.
2. Stomata are generally absent	Present.	Present but less in number confined to lower surface, usually sunken.
Physiological		
1. Habitats mostly in oxygen deficient content, thus having an efficiency of respiring anaerobically or have low oxygen requirement.	Normal physiological process, with temporary wilting at room temperature.	Most of the features directed to reduce the transpiration rates ; endurance of dessication.

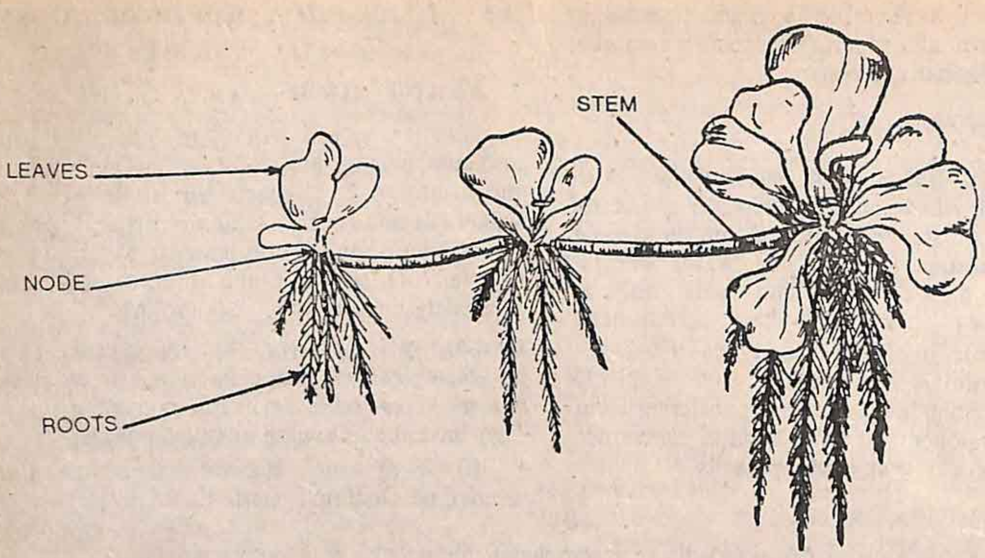


Fig. 1·2 Offsets of Pistia (Jal Kumbhi)

(*ii*) The roots are poorly developed without root hairs and root cap.

(*iii*) In some plants roots are completely absent *e.g.*, utricularia, ceratophyllum.

(*iv*) The stem is soft and delicate and is spongy from inner side.

(*v*) Large air cavities are developed in stem which help in floating and also serve to store up air (oxygen and CO_2).

(*vi*) Vascular bundles are poorly developed. Phloem is reduced to a few narrow sieve tube while xylem is reduced to a few element.

(*vii*) In some cases leaf petiole becomes bulbus which help in floating.

(*viii*) In some cases the stem and the leafpetiole are provided some spines which protect the plant from the attack of aquatic animals.

(*ix*) Leaves may be submerged or floating.

(*x*) The submerged leaves are either narrow or linear type or if they are broad, they are dissected.

(*xi*) Submerged leaves are devoid of stomata on either side.

(*xii*) Cuticle is absent on both the sides in submerged leaves. (See Fig. 1·3)

(*xiii*) Absorption of water, mineral salts and gases takes place through diffusion process by epidermis.

(*xiv*) Polisade tissues are absent in submerged leaves.

(*xv*) The floating leaves of which the lower surface is rested on the water upper surface possess stomata only on the upper surface while absent on the lower surface.

(*xvi*) The cuticle is present on the upper surface only while absent on the lower surface.

(*xvii*) The leaves which are above the water surface in the air, are having cuticle on both the surfaces.

(*xviii*) Stomata are present duly on the lower surface.

(*xix*) Palisade cells are well-developed just below the upper epidermis.

(*xx*) The petiole of aerial and floating leaves have a character to increase in size as the water level increases.

Examples of some common hydrophytes are :

Submerged plants : Hydrilla, Naias Vallisneria, Potamageton, Qttelia etc.

Floating plants: Wolfia, Salvinia, Utricularia, Ceratophyllum, Lemna, Pistia, Jussiaea (Fig *1.3–a*) water hyacinth. trapa, Neptunia, Azolla etc.

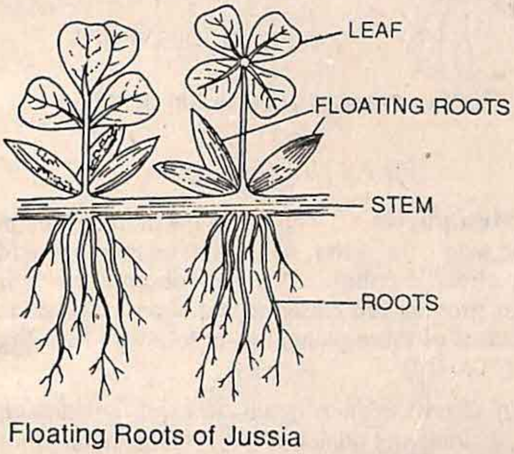


Fig. 1·3 (a) Floating Roots of Jussia

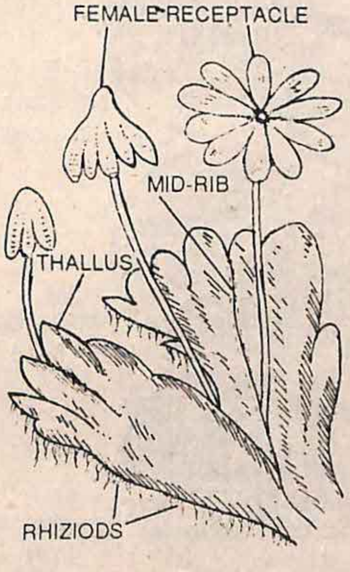
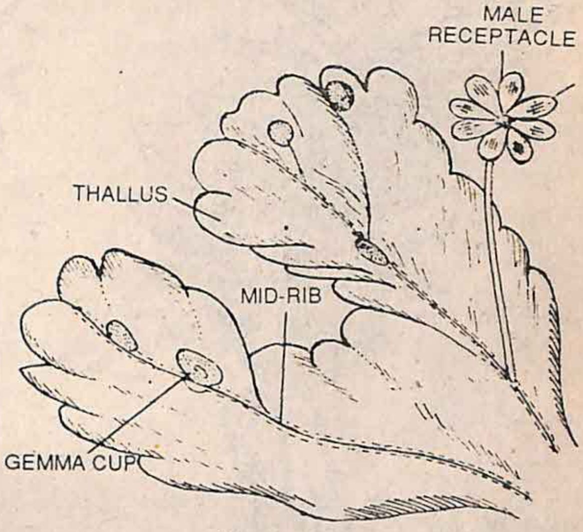


Fig. 1·4 (a) Female Thallus Marchantia Plant

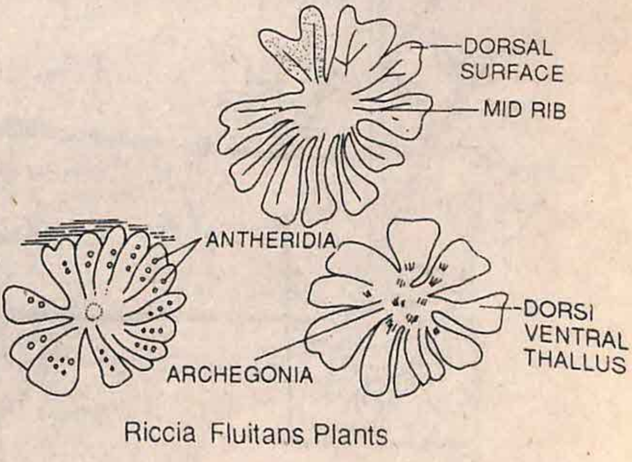
Amphibious plants : Ranunculus, sagittaria, Limnophylla heterophylla, cardenthera triflora etc.

Hygrophytes : *There are some plants which grow on constantly moist and shady places. These plants are called hygrophytes and have the following main characters :*



(b) Male Thallus

(*i*) Root system is poorly developed.
(*ii*) Vascular system is also poorly developed.
(*iii*) Stem is delicate, green, spongy and soft. In some cases the stem is rhizome type which is a kind of underground stem.
(*iv*) Leaves are well-developed with numerous stoma'a and cuticle.



(b) Male Thallus Antheridiophore and Archegoniophore of Riccia Fluitans

Examples of Hygrophytes are : Ferns Begonia, Aroids, Some grasses also, Riccia and Marchantia.

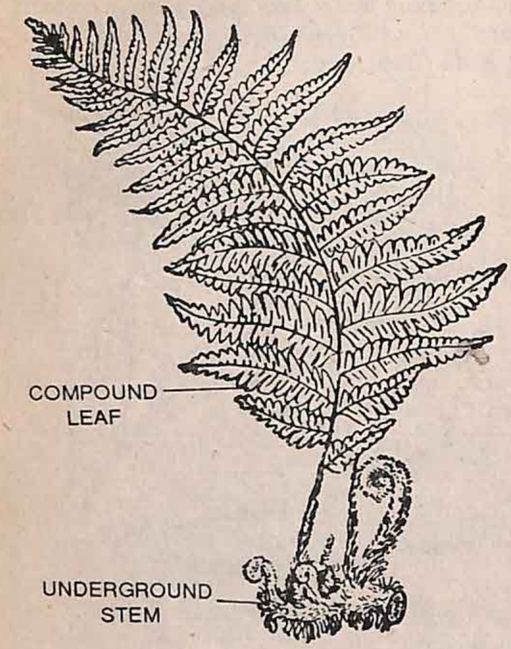
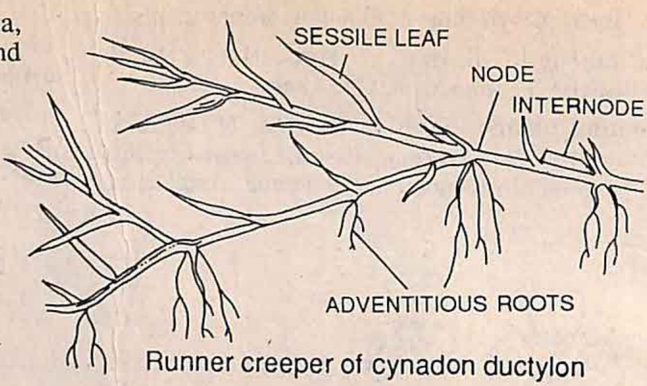


Fig *1.4 (c) Ferm Plant*



Runner creeper of cynadon ductylon

Fig *1.4 (b) (Doob Grass)*

Mesophytes : The plants which grow on plains where the water, soil, light, temperature and other climatic conditions are favourable for their proper growth, are called mesophytes. The main characters of these plants are as follows : [See Fig 1·5 (*a*) & (*b*)]

- (*i*) Roots of these plants are well-developed, long and branched with root hairs and root caps.
- (*ii*) Tap roots are found in dicotyledonous plants while adventitious type roots are found in Monocotyledonous plants.

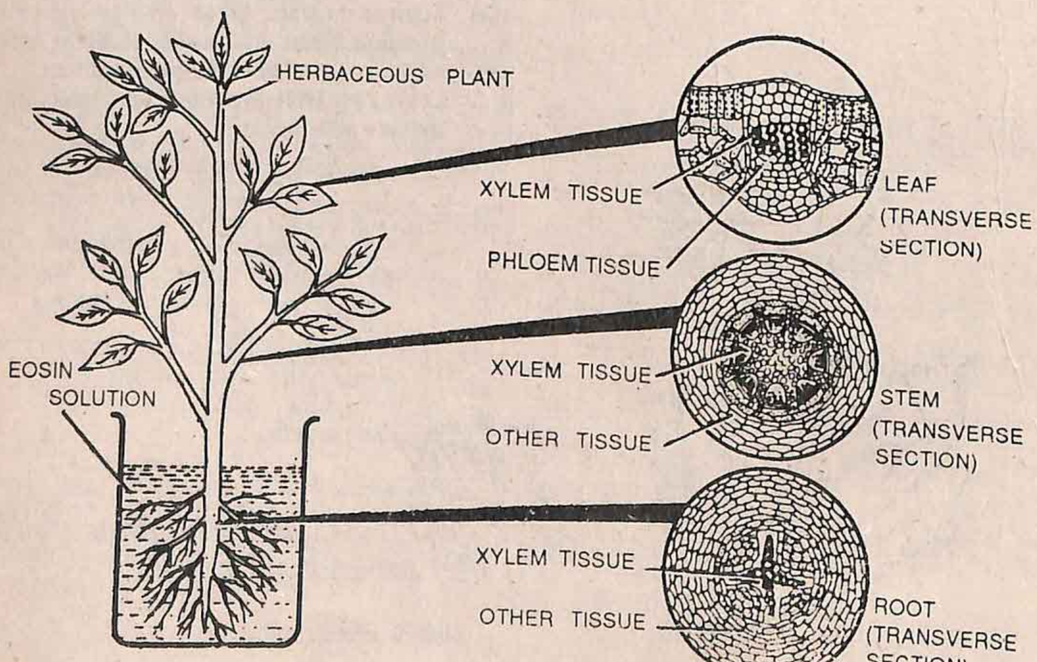


Fig. 1·5 Experiment to show that the ascent of sap takes place through xylem (*iii*) Stem is generally erect and branched. It is green in young stage and becomes brown in adult stage.

(*iv*) Secondary growth takes place in dicotyledonous stems and roots but not in Manocotyledonous stems and roots.

(*v*) Vascular bundles are well-developed.

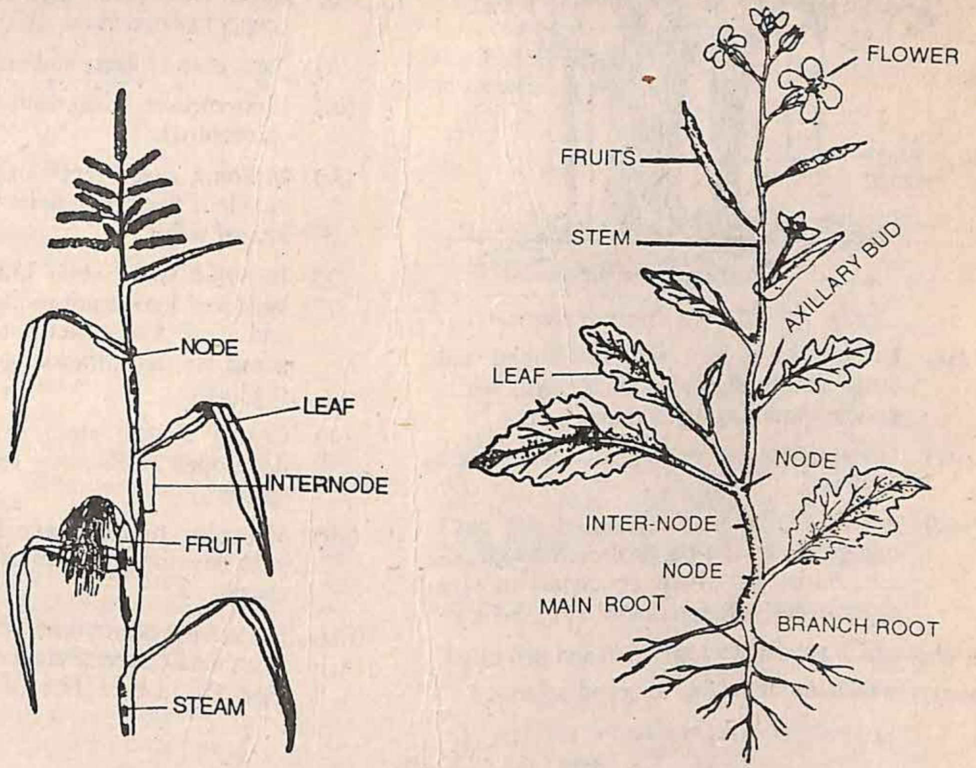


Fig. 1·5 (a) Monocot Angiospermic plant *(b) Dicot Angiospermic plant*

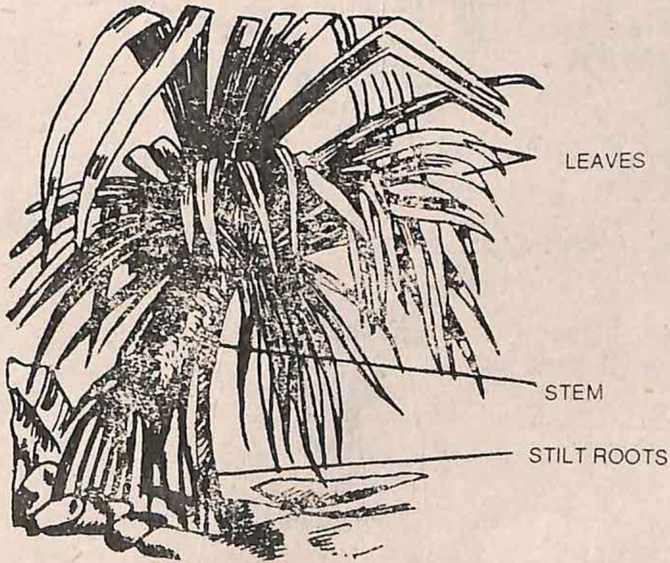


Fig. 1·5 (c) Stilt roots of Kewara

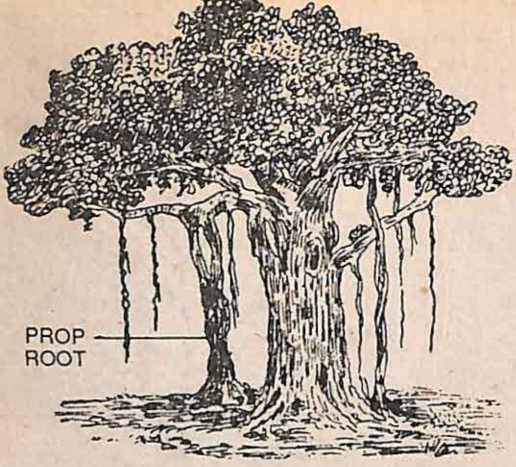


Fig. 1·5 (d) Prop Roots of Banyan

(*vi*) Leaves are green, well developed and Petiolated in dicotyledonous plants while sessile in mono cotyledonous plants.

(*vii*) Generally sexual reproduction takes place in them.

(*viii*) All these plants are classified into three categories on the basis of their length — *i.e.*, herbs — which are small in size delicate and green in colour. (Fig. 1·5 a)

Shrubs–which are few feet in length and perennial.

Trees –which are many feet long and perennial.

Xerophytes : *The plants which grow in deserted areas where water is not available adequately are called as Xerophytes.* These plants have the following main characters :

(*i*) Roots are well-developed, branched and deeply inserted in the earth.

(*ii*) Stem is stout, erect and branched.

(*iii*) Epidermis is thick-walled but devoid of chlorophyll.

(*iv*) In some cases lenticles are absent but cuticle is thick with hairs which check the loss of water.

(*v*) In some cases stem branches, axillary buds and leaves are modified into spines and stem is modified into thorns just to avoid the transpiration as in opuntia (See Fig. 1·6)

(*vi*) Cortex in the stem region is poorly developed with very less intercellular spaces.

(*vii*) Vascular bundles are less developed with developed sclerenchymatous bundle sheath.

(*viii*) Leaves are either modified into spines as in cactus Opuntia, Solanum Xanthocarpum (See Fig. 1.6 & 1.7) or are poorly deve-

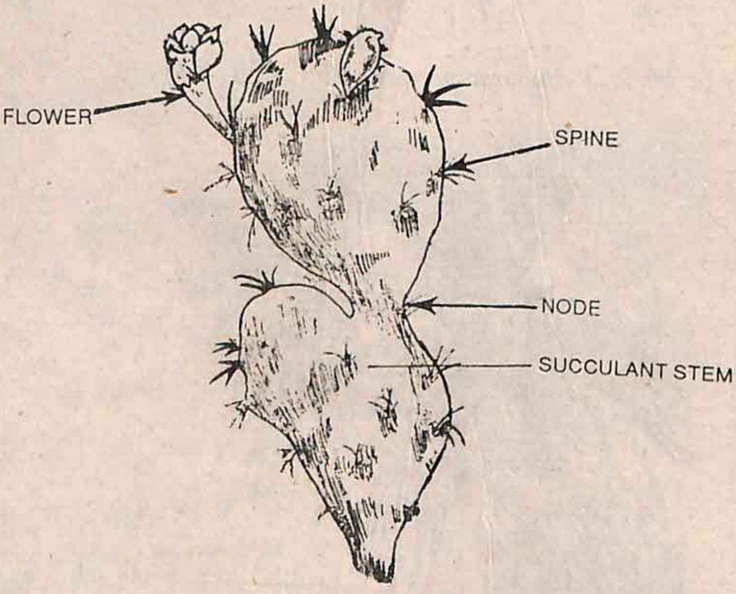
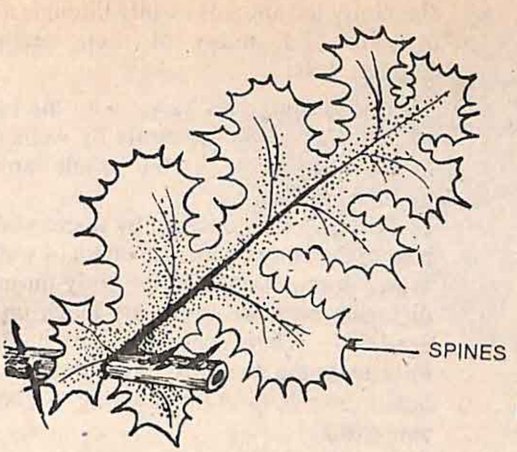


Fig. 1.6 Opuntia



(a) Leaf of Solanum-xanthocarpum
Fig. 1·7

loped and stem becomes green and succulent. This condition is known as Phylloclade.

(*ix*) Stomata are less in number situated on the lower surface of the leaves.

(*x*) These stomata are generally sunken type which help in decreasing the loss of water as you see in Nerium [See Fig .1.7 (*a*)] and Agava [See Fig. 1·7(*b*)].

(*xi*) Water storing tissues are present. Some common examples of xerophytes are—Acacia arebica (*Babool*), Cactus, Opuntia, Bryophyllum. [See Fig. 1·7 (*c*)]

Ecological Habitats in Animals : You have studied about the plant habitats in the same way animals are also widely distributed in the whole universe but all animals are broadly categorised into three groups — (1) Hydrozoic, (2) Terrestrial and (3) Aerial.

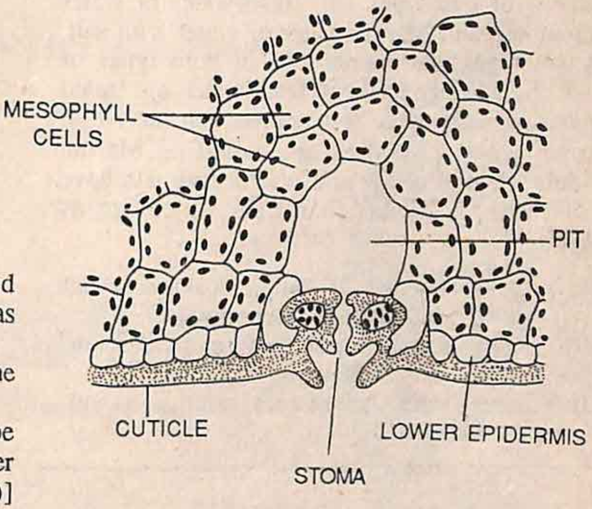
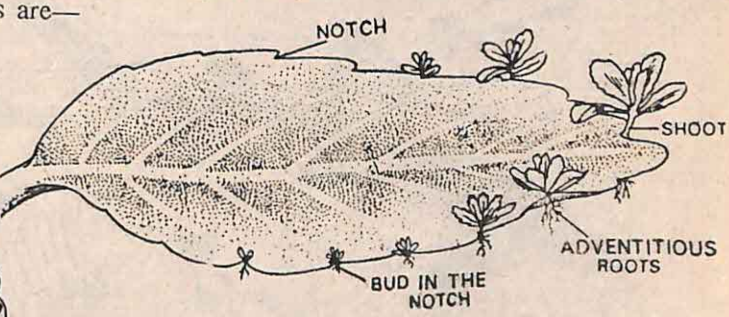
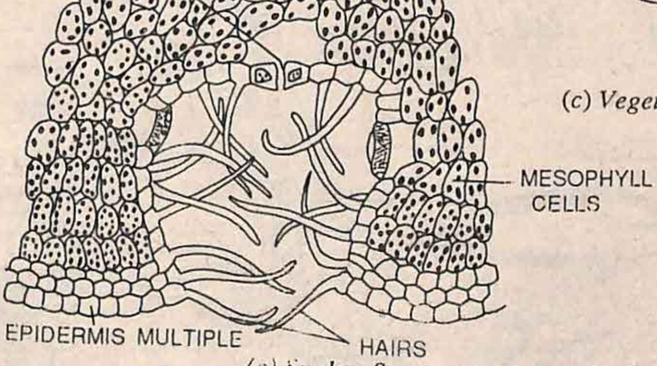


Fig. 1·7 (b) Stomata in pit in Agava leaf



(c) Vegetative reproduction in Bryophyllum leaf



(a) Sunken Stomata in Nerium leaf

Fig. 1·7 A part of T.S. a succulent xerophytic leaf showing thick curticle and sunken stomata.

1.6 ADAPTATION

(Structural and Functional Potentialities of Organisms)

1. Animals Living in water (Hydrozoic) :

Water is also a good medium for some animals to live in. These animals are called as Hydrozoic. Water is of two types *i.e.*, fresh water or water without salt and Marine water or water with salt. All water animals cannot live in both types of water. Some can survive in fresh water, are called Aquatic animals while some others can survive in marine water. So they are called as Marine animals. Both aquatic and marine animals have similar morphological characters which are as follows :

(*i*) Body is bilaterally symmetrical and stream lined which helps in swimming.

(*ii*) Generally the whole body is divided into head, trunk and tail.

(*iii*) Head bears a pair of eyes, mouth parts and snout.

(*iv*) Generally the animals respire through skin diffusion but many of them respire through gills.

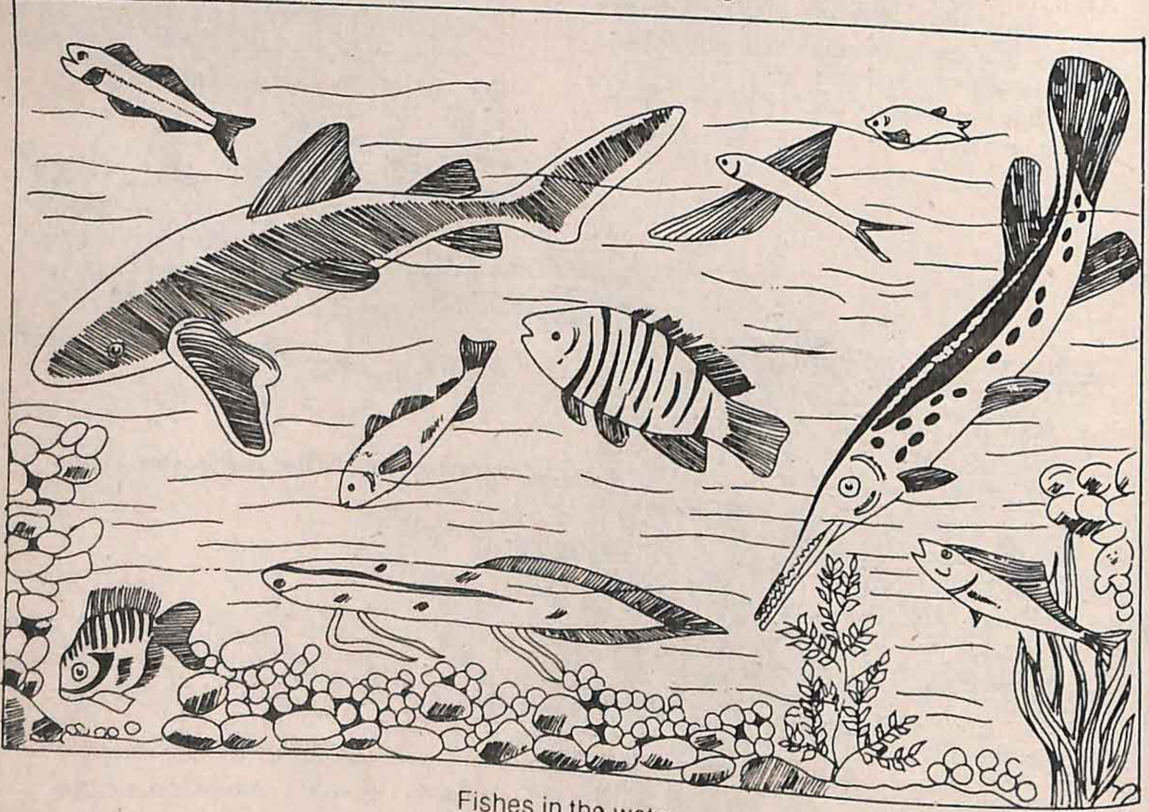
(*v*) Mostly locomotion is done with the help of fins (Fig. 1·8) but rarely by webs (as in ducks, frogs etc.,) while whale moves through Paddles.

(*vi*) Body is generally covered by scales which protect the body by the bad effect of water. Water does not enter in the body through diffusion because scales are made up of dead cells. These scales are hard and bad in taste so the enemies do not hunt them. Scales also help in maintaining the body temperature.

(*vii*) Tails also help in locomotion. The animal changes its direction with its help.

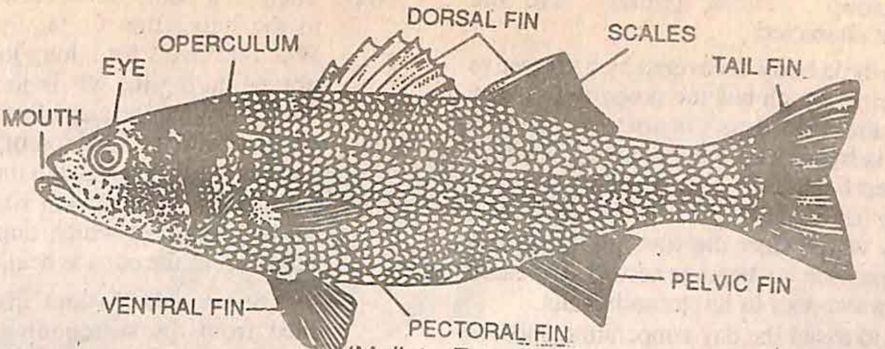
(*viii*) Bony fishes have air bladder which acts as the hydrostatic organ.

(*ix*) Skin is devoid of hair, sebaceous gland, oil gland etc. It is slimy due to the presence of cutin which helps in escaping from the grip of enemy and also does not allow the exchange of material *e.g.*, in frog.



Fishes in the water

Fig. 1·8 (i)



(Mullet—External Structure)

Fig. 15·8 (ii)

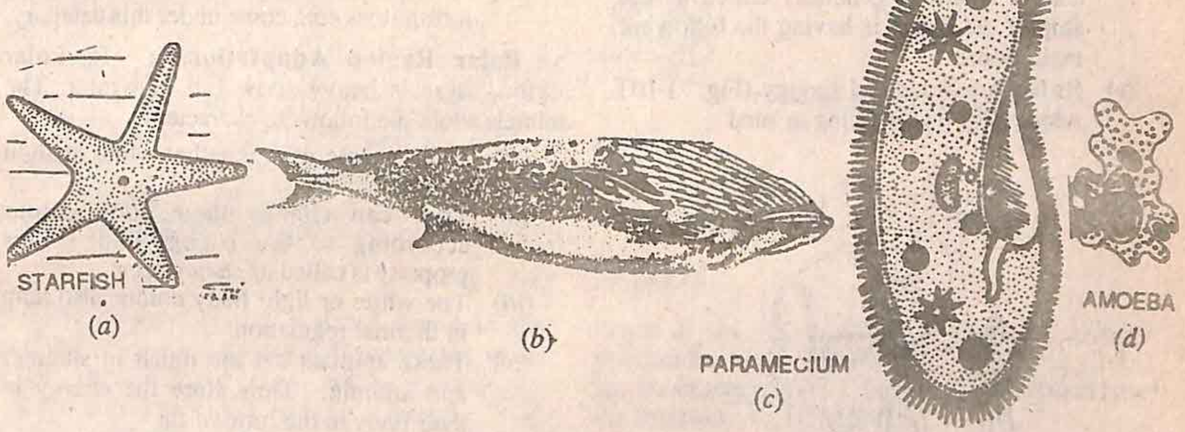


Fig. 1·9 (a) Star fish, (b) Whale, (c) Paramicium, (d) Amoeba.

(*x*) In whale there is a thick layer of fat present just underneath the skin which is called as blubber.

(*xi*) They are egg laying or oviparous.

(*xii*) The whole process of development takes place in water.

Some examples of water living animals are as shown in Figs. 1·8 & 1·9 -- Fishes, snakes, frog, whales, star fish, Malluscs, Annelids, Prawn; Crustatia, Protozoans, Coelenterates, etc.

2. Terrestrial Animals:

A vast majority of animals live on earth. They are distributed in all types of climates. Some of them live in burrows, some hide themselves in the forests while some are tamed and live in the colony along with human beings on the basis of the climatic conditions the animals adopt some characters which help them in their survival. So all the terrestrial animals are further categorised in the following groups on the basis of their adaptations :

(*a*) **Arborial Adaptations :** The animals which are arborial in nature have the following main characters :

(*i*) The whole body is covered by scales and hairs which help to maintain the body temperature, prevent from slip and maintain the water quantity in the body.

(*ii*) Tail is present throughout the life which may be prehensile or erect but it helps in climbing, in removing or keeping away the mosquitoes,flies etc., and enemies too.

(*iii*) Pectoral girdle is broad which helps in supporting the body weight and protecting the delicate internal organs from external shocks.

(*iv*) The Pelvic girdle is also well-developed which give support to the body organs.

(*v*) The fingers are present in fore and hind limbs in such a way that they can grasp the thing or perch the twig easily.

(*b*) **Xerophytic Adaptations :** The animals which live in desert or in hot place come under this group. These animals have the following main characters :

(*i*) The whole body is covered by a protective covering which has the property to check over the water loss. In some animals the skin is hygroscopic in nature, *e.g.*, Moloch (Desert lizard).

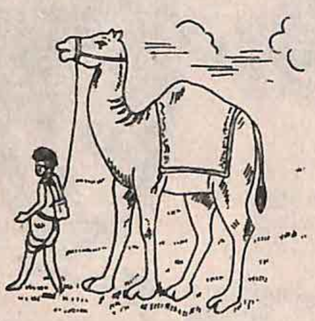
(*ii*) They have some specialised cells in their body which store the water in themselves and provide it whenever needed. The camel has water-sacs in its stomach walls.

(*iii*) Just to avoid the day temperature, most of the animals are nocternal.

(*iv*) They have poison glands or sting which help in defence.

Camel which is generally called as the ship of the desert is having the following main points :

(*v*) Its feet are broad and spongy (Fig. 1·10) which help it in walking in sand



Camel showing xerophytic adaptation

Fig. 1·10

(*vi*) It has the capacity to store water upto 50 litres and can live without water upto fortnight. The stored water is evenly distributed in all the cells of the whole body. It can withstand dehydration upto 25 per cent of its body weight.

(*vii*) It excretes out concentrated urine and faecal matter with less amount of water.

(*viii*) The rate of perspiration is also less because firstly it losses water from the tissues rather than from the blood. Secondly it can adjust its internal temperature to its surrounding upto a maximum of 45°C.

(*viii*) Breathing rate is also very slow which helps in decreasing the loss of water from the body.

(*ix*) There is a hump on its back which is due to the deposition of fat for future use. When it travels for a long journey it does not eat during the whole journey. In the course of time the size of hump decreases because of the utilization of the fat in the form of food deposited in the hump.

(*x*) It has thick coat of skin which regulates its body of skin which temperature and adjusts it to the outside heat.

Some animals and insects use the heat from the surrounding to maintain their body temperature. So they are called as Ectotherms. They are generally cold blooded. They are active in clear days and in summer season. Lizards, snakes, mosquitoes etc., come under this category.

Polar Region Adaptations : In Polar region, there is heavy snow fall in winter. The animals adopt the following characters :

(*i*) Their body colour is either white or light coloured.

(*ii*) They can change their body colour according to the background. This property is called as *camouflage*.

(*iii*) The white or light body colour also help in thermal regulation.

(*iv*) These animals eat too much in summer and autumn. They store the energy in their body in the form of fat.

(*v*) In winter season, they go for hibernation (winter sleep). The stored fat is utilized as food to provide energy.

(*vi*) During hibernation metabolic activities are reduced upto minimum.

(*vii*) Plants and animals of this region are also short in length. *e.g.*, Tibbatian Yak (See Fig. 1·11).

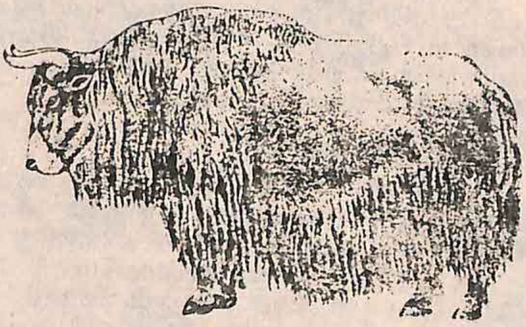


Fig. 1·11 Tibbatian yak

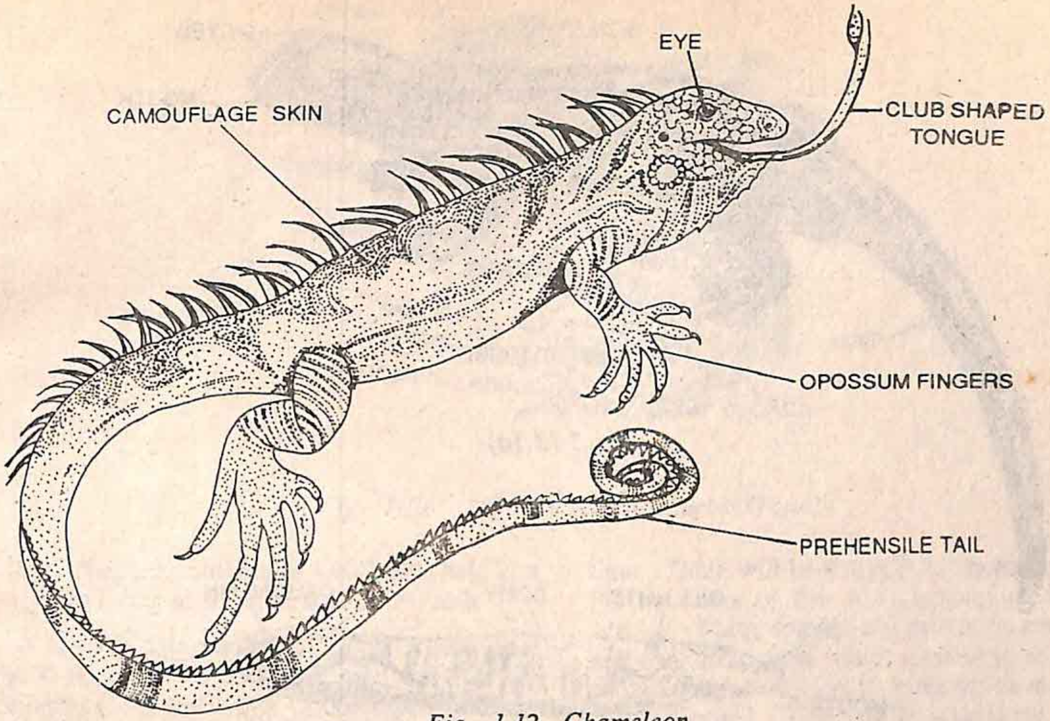


Fig 1·12 Chameleon

The Chameleon is a lizard found in the forest on trees. It is remarkably adjusted to its environment. Its tongue is very long about one foot, muscular and club shaped anteriorly. (Fig. 1·12). It can capture the insects with the help of tongue. Its forelimbs and hindlimbs are short in length but the fingers are placed in the hands in such a manner that it can grasp easily (opossumly). Two fingers are opposite to the three fingers. Tail is present throughout the life which is prehensile, and long. It has a pair of eyes on the face. The eyelids are circular in shape. They can increase or decrease the diameter of the eyes. It can move its eyes in all the directions. Each eye is independent in its vision. It can see in all the directions at a time. It has a great power to change its body colour according to the surroundings colour. This property to change its body colour is called camouflage. Due to this property, it protects itself from its enemies.

Amphibious Adaptations : There are some animals who live in two habitats. Generally these animals live in water as well as on earth. Some animals lay eggs in water, develop there and when they become adult they come out on earth and pass their whole life there. On the contrary, some animals live in water but for reproduction and laying of eggs they come on earth and then they go again in the water. Frog, mosquitoes, spotted salamander, tree frog, ichthyopis etc., (Fig. 1·13) are the examples of this group. Frog and toad have the following main characters :

(*i*) They are cold blooded so they go for hibernation in severe cold and also go for aestivation in scorching heat.

(*ii*) They have foot webs specially in hind limb which help in floating.

(*iii*) Forelimbs are shorter than hind limb which help in jumping during locomotion.

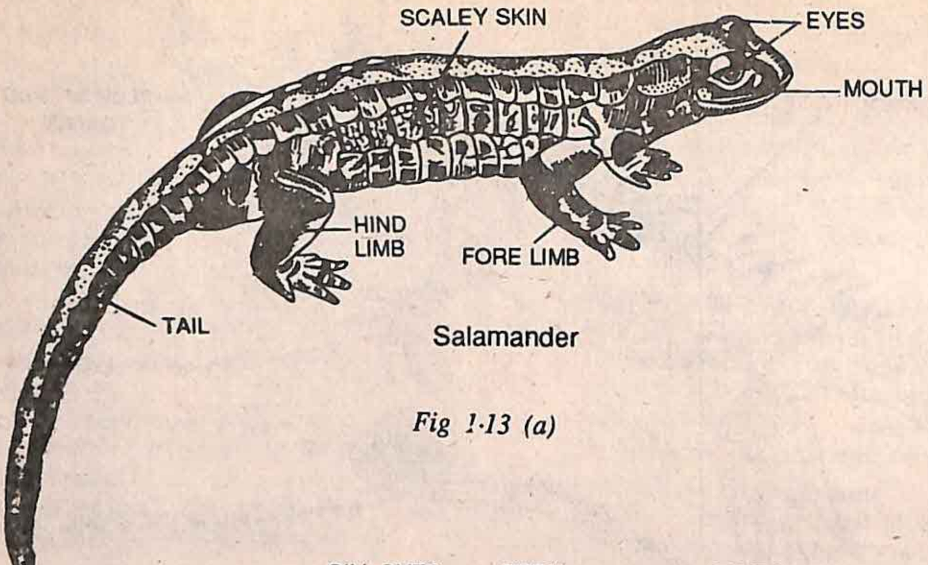
(*iv*) Head is triangular which helps in swimming.

(*v*) Neck is absent which also helps in jumping and swimming.

(*vi*) They have the power to change its body colour according to the colour of surrounding (Camouflage).

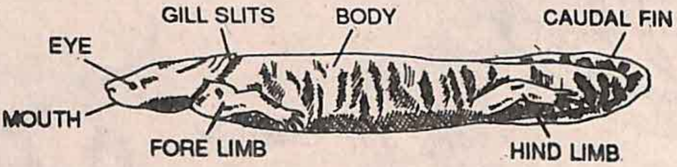
(*vii*) The female lays eggs on the water surface where they develop and grow. All the stages of the development occur in the water.

(*viii*) Skin is slimy, spotted and loosely attached with the body.



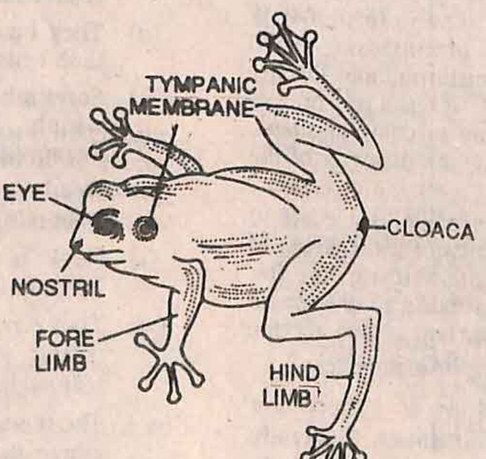
Salamander

Fig 1·13 (a)



Necturus (Mud Puppy)

Fig 1·13 (b)



HYLA (THE TREE FROG)

Fig 1·13 (c)

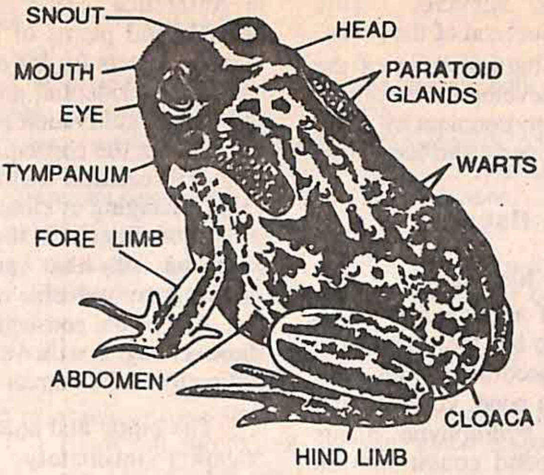


Fig. 1·13 (d) Bufo Melanostinetus (Toad)

(*ix*) They are carnivorous which also help him in living in water as well as on earth.

Need of Adaptation : You know that there is no place on earth specified only for the members of one species or of one type organism. You will find several types of animals and plants living together at one place. The climatic conditions of that place may be suitable for some animals and plants but may not be favourable for others. So they have to modify their way of living or body organs in such a way that they may survive and can conduct all the biological activities not for their survival but also for the continuity of their race. (See Fig. 1·14)

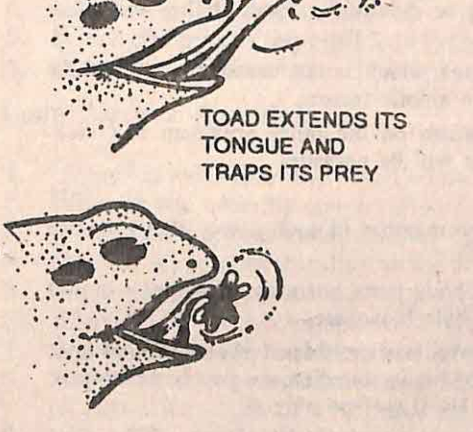


Fig 1·14

If they are unable to modify themselves or their behaviour they will not survive for a long time. There will be struggle for existence among the members of the same species or the other species. Many species can attack on one species and may destroy the whole species so that species should adopt characters in itself which may help it in its survival. This can be explained with the help of an example. In a field there will be so many insects along with the crop. All these insects will eat the plants and will destroy them. So to protect the crop D.D.T., the insecticides, is sprayed in the field. Some of the insects will not tolerate its effect so they will die while some other insects have the power of tolerance for D.D.T. therefore, they will survive in that condition. They will breed and the young ones will be having the power of tolerance for D.D.T. with the result of that this species will survive due to immunization. Its number will increase the population resistant to D.D.T. This power of resistance against D.D.T. is induced in that population of insects.

Charles Darwin has also explained this adaptation in his theory and called it as survival of the fittest and natural selection. Both these facts can be explained with the help of another example.

There are a large number of varieties of animals living in the desert. They have to tolerate the excess of heat and the scarcity of water. Some of them cannot tolerate such conditions with the result of that they will not survive for a long time while some others can tolerate the heat and are resistant to water so they will survive. They will feed, breed and flourish. They are able to live well in such conditions. They show the adaptation required for such climate. In the words of Charles Darwin they are selected by nature to survive.

They are also capable to survive. This phenomenon is called as the survival of the fittest.

Thus, adaptation is the characteristics of the living beings to survive and develop for a definite period of time in a particular environment by doing all the biological activities properly and increasing their population.

Conservation of Habitats
or
Man can Manipulate his Habitat :

There are numerous types of animals and plants living on the earth but no one has the property to manipulate the environment according to his need for survival except man. In a pond, you will find various types of animals and hydrophytic plants like water hyacinth. The pond conditions are favourable more to water hyacinth than anyother organism with the result of that water hyacinth will flourish extensively. Other organisms cannot alter the pond's conditions.

In the same way, tigers, lions and other wild animals live in the forest. If the forest is reaped, the small wild animals will have to migrate from there. The tigers and lions will not live there because they will not get their food properly. Also they are unable to produce their food. So they will have to migrate from there. This condition is not correct with man.

Man has overcome on the climatic conditions also by making appliances. He has made his home in Antarctica, green land etc., where the other animals and plants of plain cannot survive. He cuts the forests for his own sake like trade, getting space for residential and industrial purposes. He has started cultivation in ocean also but he did not think about the consequences of what he is doing. The deforestation will effect the wild life. More flood, changing of climate, increase the percentage of carbon dioxide in the atmosphere due to which increase of heat and temperature in the environment, adverse effect on the birds, rainfall etc., will be the consequences of deforestation. All these changes will ultimately effect directly or indirectly to the human life.

The biotic and abiotic components are linked together intimately. So the crisis in one component will definitely effect to other components. Thus the destructive activities of man will disturb the whole environment. He gets food, air, water, minerals, soil etc., from the nature and use them for his survival. As the human population is increasing day-by-day, the use of these natural gifts is also increasing accordingly. But man should keep in mind that some natural resources are limited so he should use them in proper way and miserly so that these things may be utilized for long time. This nature is known as conservation ; which can be defined as "The use of natural resources wisely without any waste and replace them by any other renewable sources."

SUMMARY

The environment is basically composed of –

(*a*) The living organisms which include plants and animals.

(*b*) The non-living components which includes air, water, soil, temperature, light etc.

The habitat of the organism is the place where it lives or dwells for food, shelter and other biological needs.

Micro habitat : It is the term used in reference to an area which is not based on size of the population but are seen rarely due to the difference in abiotic factors.

Mutualism : It refers the inter-relationship of one organism on the other organism and vice-versa. In this relation one will be host and the other will be parasite.

Parasites can be endoparasite or ectoparasite.

Symbiosis : It is the relationship of organisms which live together in such a way that both are benefited from each other.

Plants, found in all types of habitats, have the same body parts but vary in shape, size and functions. There are three types of habitats in the whole biosphere—

1. (*a*) *Hydrophytes* : These are watery plants which have less developed roots without root hairs and root cap. Stems are soft, delicate, spongy vascular bundles are poorly developed. Leaves are dissected, green, having stomata on their aerial surface only.

   (*b*) *Hygrophytes* : Some plants grow on constantly moist and shady places. These are termed as hygrophytes.

2. *Mesophytes* : Plants growing in the plain area are called as mesophytes. Their roots are

well-developed, with root hairs and root cap.

Stem is developed and branched.

Leaves are green, petiolated or sessile containing stomata on one or both surfaces. Vascular bundles are well developed. Sexes are developed in flowers.

3. *Xerophytes :* Plants growing in deserted area are called Xerophytes. Their roots are well developed. Stem is stout, erect and branched. Cuticle is thick. Leaves are modified into spines or become thick, succulent, green and flat. Stomata are sunken.

Like plants, animals are also classified under the following heads :

Hydrozoic : The body of such animals is bilaterally symmetrical covered with scales. Fins and tail help in locomotion. They are egg laying. The whole process of development occurs in the water.

Terrestrial : Vast majority of animals live on earth. They live in burrows, hide in forests and are tamed.

Arborial : Body is covered by scales or hairs which help in maintaining the body temperature and water quantity. Tail is present throughout the life which helps in climbing and removing mosquitoes and flies. They are pentadactyla.

Some animals have xerophytic adaptations while some animals living on poles have polar adaptations. Some animals have the characters of amphibious adaptations.

Need of Adaptation : There are variations in the climatic conditions from place to place. So to adjust themselves in the adverse conditions, the animals adopt or change in their behaviour, structure of the organs and habits.

QUESTIONS

1. Define the following :

(*i*) Ecology (*ii*) Biosphere (*iii*) Habitat (*iv*) Camouflage (*v*) Deforestation (*vi*) Afforestation (*vii*) Parasite (*viii*) Adaptation

2. Differentiate the following :

(*i*) Habitat and Environment (*ii*) Ecological Balance and Ecological crisis (*iii*) Habitat and microhabitat (*iv*) Habitat and Ecological niche (*v*) Mesophytes and Xerophytes (*vi*) Arborial animals and Aerial animals (*vii*) Symbiosis and Commensalism.

3. Give the answer to the following either in one word or in one sentence :

1. Who has controlled the environment ?
2. Will deforestation be useful or harmful to human being ?
3. Write the name of the organ of the plant body where the Palisade tissues are found.
4. Which help the camel to keep him without water for a long time ?
5. Which character is responsible in Polar animals for camouflage ?
6. Give two examples each of Hydrophytes, Mesophytes and Xerophytes.

4. Long Answer Questions :

1. "Camel is the ship of the desert". Discuss this statement.
2. What do you mean by conservation ? Explain it with the help of an example.
3. Write some important adaptation in hydrophytic plants.
4. How do the xerophytes adjust in the deserts ?
5. "Oganisms and their habitat influence to each other." Comment upon it.
6. What do you mean by adaptation ? How does it occur ?
7. What are those physical factors which influence the land organism ?
8. Write short notes on the adaptations of—
   (*i*) Arborial animals (*ii*) Polar animals (*iii*) Desert animals and (*iv*) Amphibious animals.
9. 'What do you understand by interdependence ? Explain it with an example.
10. Explain the main points of adaptations of water animals or Hydrozoa.
11. How Chameleon is adjusted in its environment ? Explain.

CHAPTER 2

LEVEL OF ORGANIZATION

LEARNING OBJECTIVES

At the completion of this Chapter you should be able to learn—

1. The 'individual' of all organism is termed as the Organismic level. It is based on the simplicity to complexity.
2. **Lower level of hierarchy** which starts from the individual *i.e.*, complex form towards the simple form.

   Individual ← Organ system ← Organs ← Tissues ← Cells ← Cytoplasm Nucleus ← Nucleic acid
   C,H,N,O,P,S → Organic Compounds.————————————↑
3. **Higher Level of Hierarchy :** It starts from individual to the complex form *i.e.*, **Biosphere.**

   Individual → Species → Population → Community → Eco system → Biosphere.
4. The structure of the cell and its organelles along with their functions.
5. The cell division and its types *i.e.*, Amitosis, Mitosis and Meiosis.
6. The mechanism of cell division.
7. Significance of mitosis and Meiosis.
8. The difference between mitosis and meiosis.
9. Crossing over and its importance.

INTRODUCTION

There is large number of organisms around us, simple or complex. In plants, we have herbs, shrubs or trees living in different conditions. But all of them have similar plans of activity with stem, root or leaf. Similarly animals whether simple or complex have same plans of activity. To understand more about the organism and the plan of activity, it is better to first have a glimpse of relations between a machine and organism. Both machine and the organism require energy to carry out the functions assigned to them. But simply, making the energy available to them will not yield anything until their various parts are not organised in a unit. This organisation, whether in a machine or in an organism is the essentiality to survival. In living organisms this organisation is not only found in lower level but at higher levels too.

No doubt, there is diversity in the living organisms in their mode of living but even all the living beings have some similarities in their organisation. This similarity can be seen at various levels in them. The most important similarity is an '*individual*' whether it is a plant or an animal. It may be of any kind. This level is termed as the *organismic level*. It is based on certain principles *i.e.*, from *simplicity to complexity*. Just to make its study simple and easy, we start the study from an individual towards simplicity.

The individual's (Plant or animal) body is very complicated which is composed of organs. These organs are several in number which associate together to perform special vital functions. All the vital functions are performed by a group of organs. This group is called "*Organ system*'. There are ten organ system in animal body *viz.*, Integumentary system, Digestive system, Respiratory system, Excretory system, Vascular system, Nervous system, Muscular system, Reproductive system, Endocrine system and Skeletal system.

Fig. 17·1 shows the level of hierarchy from simple to complex in human body in which the various hierarchical levels regarding digestive system are shown.

Each organ is consisted by groups of similar type of cells which are named as '*tissues*'. There are many types of tissues present in the living's body. The types of the tissues are based on the structure and function of their cells. Different types of tissues present in human body are — Epithelial tissues, muscular tissues, connective tissues and nervous tissues.

The unit of a tissue is called *cell* which is the smallest structural and functional unit. It may attain any shape and size according to its function and the position in the organ.

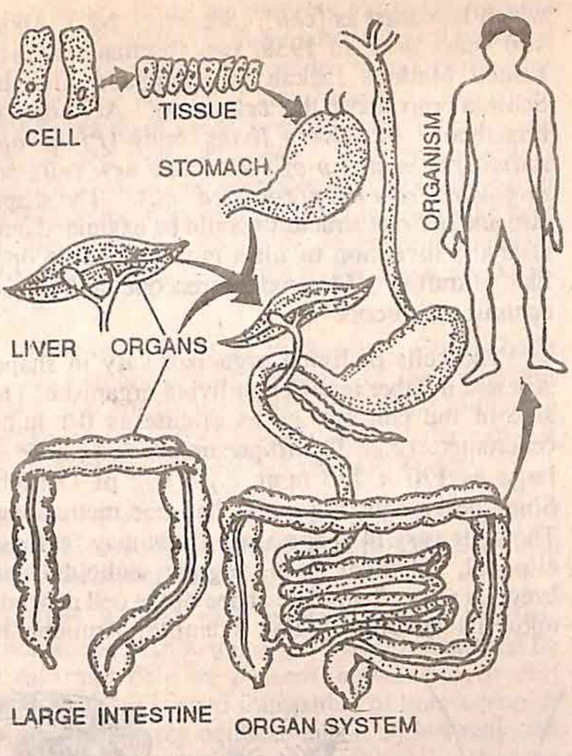


Fig. 2·1

Each cell is constituted by several types of organic and inorganic molecules. These molecules are very complicated in their constitution. Each type of molecule is composed of several elements. The smallest unit of each element is called '*atom*'. Thus the molecular level and below are non-living while the cellular level and above constitute the living world.

Higher Level of Hierarchy : The highest level of Hierarchy of organisation is called '*BIOSPHERE*' in which all the geographical parts (regions) of the earth are included. Animals and plants are found in each geographical part which are different from the other animals and plants of other geographical parts due to the difference in geographical and climatic conditions. Therefore, the groups of plants and animals of one geographical region are commonly termed as *Biome or Eco-system* (Fig. 2·2), these living groups make favourable relations with the non-living or abiotic conditions of that region only then they survive otherwise they die.

Each geographical region is again divided into several zones. *The climatic conditions of one zone*

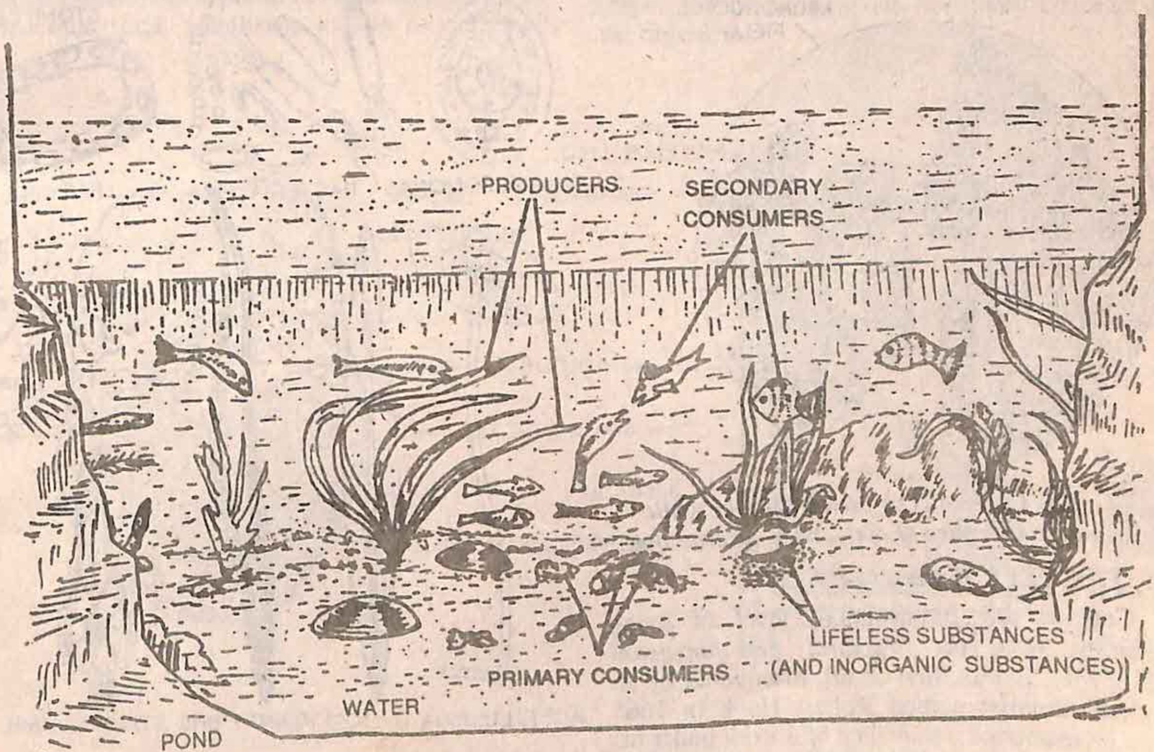


Fig. 2·2 Pond Ecosystem

is different from the climatic conditions of others. So all the plants and animals of one zone are dissimilar to the plants and animals of other zone. So, all the plants and animals of one zone is called "*Community*' of that zone. The animals of one zone depend on the plants of that zone for their food.

There are various types of animals found in one zone. These animals live together by making colonies. Each colony is composed of similar characters. So such group of one type of animals living in a particular area in a definite period is called population of the area of that period. The group of similar animals taking part in reproduction, increase their number and also perform other vital functions is commonly called as '*species*'.

Each species is a group of individuals having morphological, anatomical and physiological similarities. Each individual is called '*organism*'.

Thus an organism or individual is the basic level or higher level or it may be called as the intermediate link between lower level and higher level.

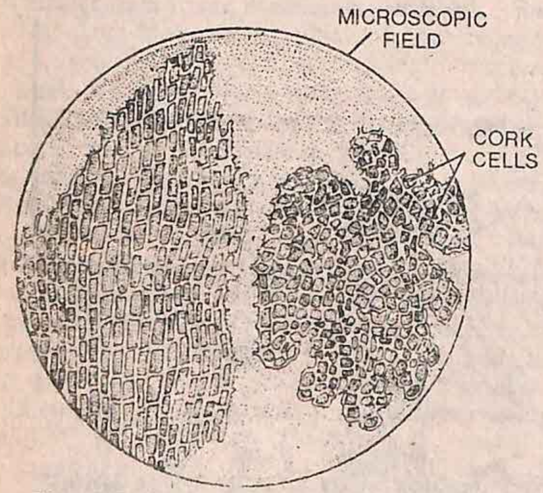


Fig. 2·3 Cork cells as seen by Hooke while observing a thin slice of cork under Microscope.

2.1 THE CELL

Cell is the fundamental level of living hierarchy. *It is the structural and functional unit of life.* It was, first of all, discovered by an English scientist named Robert Hook in 1665 when he examined a thin slice of a cork under his microscope. He found many tiny holes in it to which he called as '*cell*'. (See *Fig. 2·3*.) About 200 years later, in 1938, two German scientists named Mathias Jackab Shielden and Theodar Schwan propounded the '*cell theory*'. According to this theory — "*Every living body (Plant and animal) is made up of cells. The new cells are originated from the pre-existed cells.*" The shape, size and internal structures could be examined only after the invention of ultra modern microscopes like 'Ultrafuse', 'Electron-microscope' and 'Phase contrast microscope' etc.

The cells of living organism vary in shape, size and number in different living organism. The size of the cell can be as minute as 0·1 m.m. (micrometre) *e.g.*, Pleuro-pneumonia and can be as large as 170 × 135 m.m. *e.g.*, egg of Ostrich. Some nerve cells are more than one metre long. The cells vary in shape also. Cells may be long, eliptical, spherical, oval, angular, cuboidal and irregular (Fig. 2·4). The shape of the cell depends upon its function. For example, Amoeba is

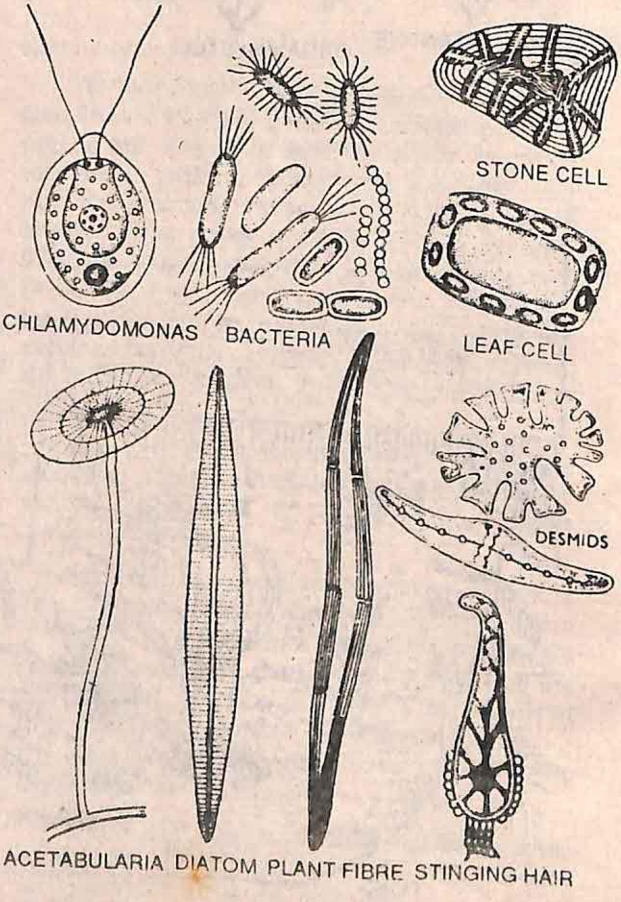


Fig. 2·4 Different cell shapes of plant cells.

unicellular. It has the property to change its body shape. It changes its shape when it locomotes or it catches its prey. The white blood corpuscles (W.B.C) of the blood also have the property to change its body shape because it has to catch and engulf the disease germs. The nerve cell is elongated with fine branches at both the ends. It makes connection with the other cell with the help of these branches and thus can pass the impulses from the recepting organs to the brain and vice-versa.

The cells also vary in number. On the basis of the number of cells, the size of the organisms vary. An ant is small and an elephant is big not because of the difference in size of the cell but because of the difference in number of cells.

Cell Structure : As regards the structure of the cell the animal cell and plant cell are alike with some variations (See Fig. 2·5).

The animal cell as seen under electro-microscope is shown in Fig. 2·6. It is bounded by a thin and delicate *plasma membrane* or cell membrane. It is semi-transparent or translucent. It is also selectively permeable as it allows only few substances to enter. It protects the cell inclusions from external shocks. The plant cell also have the cell membrane but it is also covered externally by a somewhat thick membrane known as *cell wall* which is constituted by cellulose, an organic dead and complicated compound. It not only maintains the shape of the cell but also protects from the external shocks.

The whole inner space of the cell is filled with a jelly-like, granular, translucent, viscous liquid, the *Cytoplams*. Many tiny cell inclusions float in this liquid. Cytoplasm does not allow the cell organelles to strike against each other. It also acts as the medium for the transaction of the materials. It maintains the cell temperature and pressure both. In cytoplasm of the cell, there may be one or more empty spaces known as vacuole. They are tiny and may contain cell sap. These vacuoles are quite big in plant cell which have a thin inner layer known as tonoplast.

There is a spherical, dense structure floating in the cytoplasm which is called *nucleus*. It is centrally placed in the animal cell while at one side in the plant cell. It has its own covering named as Nuclear membrane. Nucleus contains Nuclear sap, one or more nucleoli and a definite number of chromosomes which are definite in number. Each chromosome is made up of many genes which are arranged in a linear fashion. Each gene is made of DNA and RNA materials which are responsible for carrying one hereditary character of the organism.

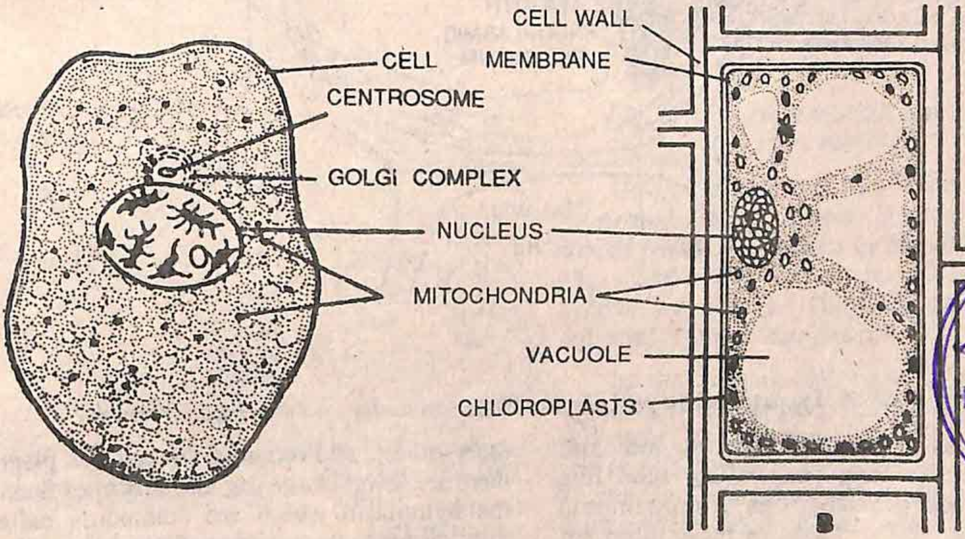


Fig. 2·5 An Animal cell and A plant cell as seen under compound microscope

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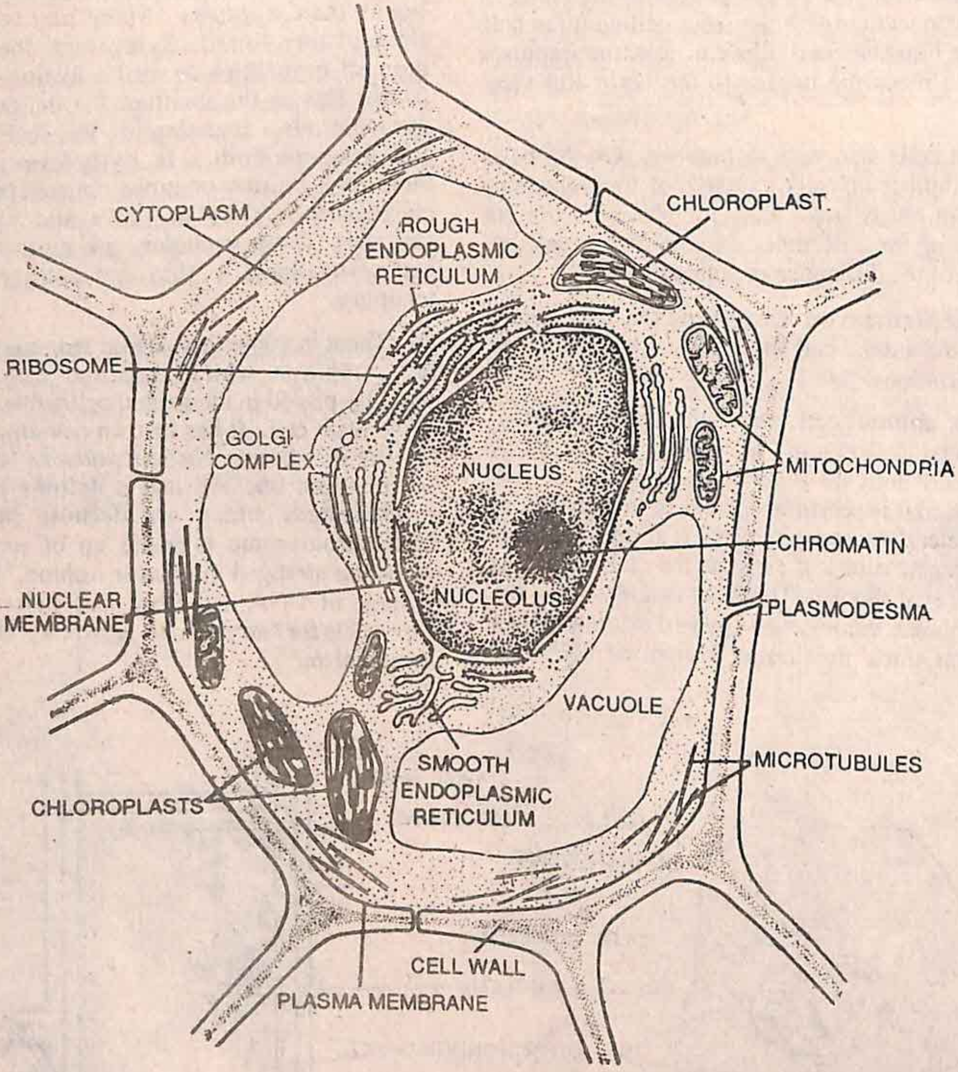


Fig. 2·6. A Typical animal and plant cell as seen under an electron microscope

Nucleus is externally surrounded and interconnected by long and hollow tube like structures which are called, as *Endoplasmic reticulum* (Fig. 2·7). Some of these tubes are single layered while some are double layered. The outer layer is made of tiny particles, the *Ribosomes*. These ribosomes are responsible for the synthesis of Protein in the cell. In plant cell, there are several large bag like structures floating in the cytoplasm which are commonly called as Plastids due to the presence of which the cell seems coloured. These plastids are of three types. On the basis of the chemical compounds present inside in the form of powdery pigment. One type of plastids

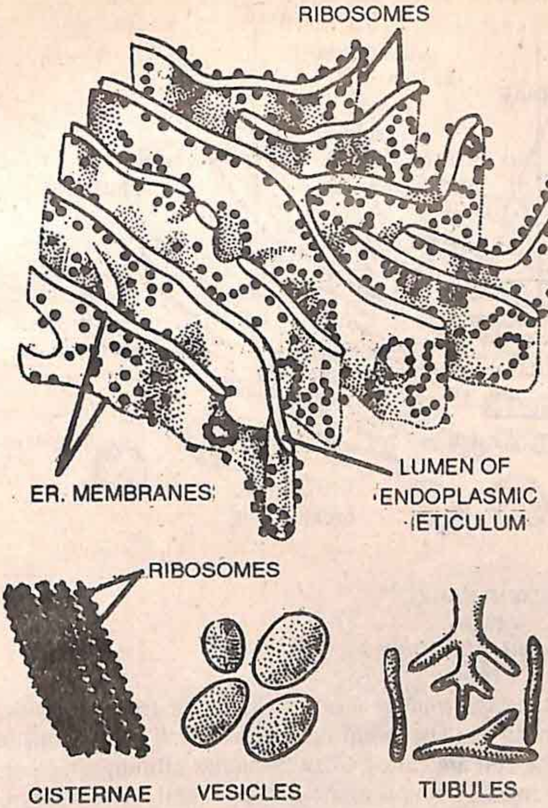


Fig. 2·7 Endoplasmic reticulum studded with ribosomes.

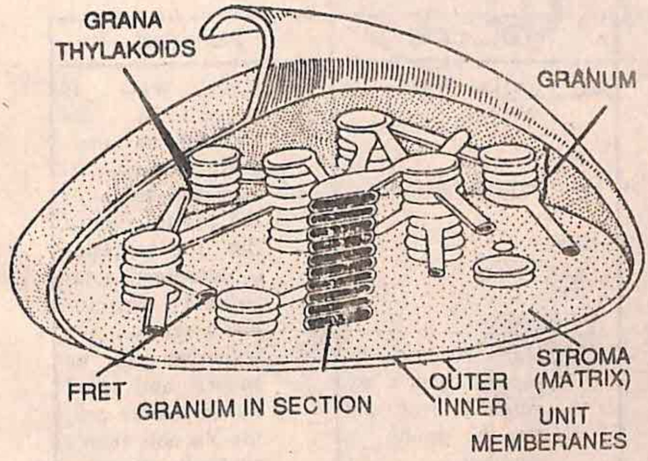


Fig. 2·8 Chloroplast as seen in cross-section.

are called ***chloroplasts*** *(Fig. 2·8.)* due to the presence of chlorophyll, a green pigment. Another type of plastids are called as Leucoplasts which contain which pigment inside while the third type are called Chromoplasts which contain the Pigment of any colour except green and white. Animal cell is devoid of plastids except Euglena, an autotropic animal.

Another important organelle to be noticed is the *Mitochondrion* (pl. Mitochondria) Fig. 2·9. It is hollow thread like structure which is responsible for the total oxidation of the food in the cell and to liberate energy required by the other cell organelles. These mitochondria float haphazardly in the cytoplasm. They are also called as the *power-house of the cell.*

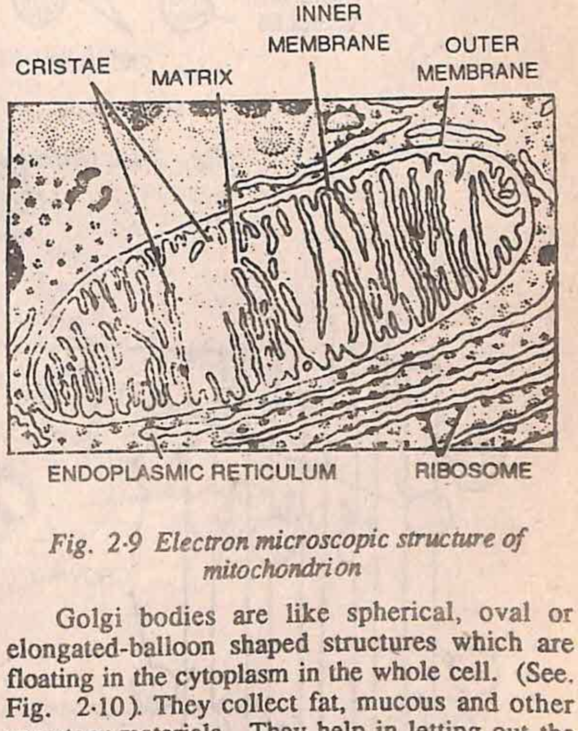


Fig. 2·9 Electron microscopic structure of mitochondrion

Golgi bodies are like spherical, oval or elongated-balloon shaped structures which are floating in the cytoplasm in the whole cell. (See. Fig. 2·10). They collect fat, mucous and other secretory materials. They help in letting out the collected material from the cell.

In the animal cell only, a spherical cell organelle is also present situated near the nucleus. It is named as *Centrosome (*See Fig. 2·11). It has one or two dot-like structures placed centrally are known as Centrioles which are surrounded by centrosphere the granular, viscus and distinctly visible substance. This organelle helps in the cell division. It is absent in the plant cell.

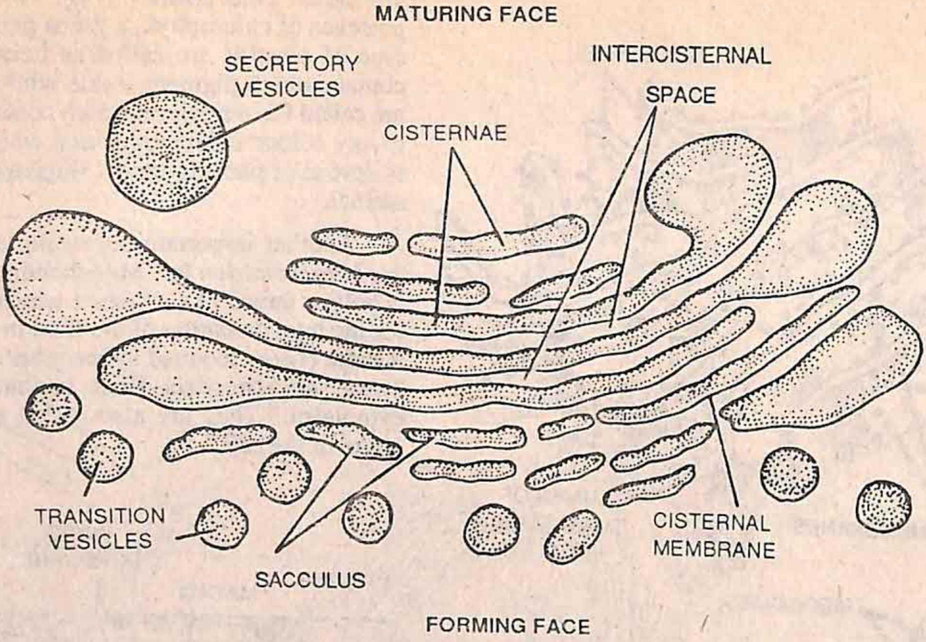


Fig. 2·10 Ultrastructure of Golgi Complex

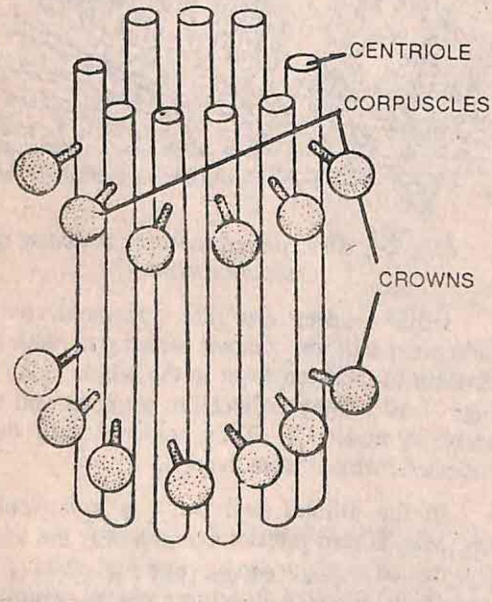


Fig. 2·11 T.S. of centriole as revealed by electron microscope.

Some animal cell and some plant cell also contains one or more projections from the outer surface. The small but several such projections of the cell are called *Cilia* (Singular-cilium) which are generally found in the bacterial cell. The long but only one projection present on one end of the cells called *Flagellum* (Pl. — flagella). Both cilia and flagella help in movement of the cell. (See. Fig. 2·12).

On the basis of the above study of animal cell and plant cell, their comparative study can be summarised in the following manner :

Animal Cell	*Plant Cell*
1. Cell wall is absent.	1. Cell wall is present in the form of the outermost covering.
2. Plastids absent.	2. Any one type of the plastid out of the three types (chloroplast, Leucoplast chromoplast) present.
3. Vacuoles may be present which are small in size and can be many in member.	3. Vacuoles can be several and small but in mature cell, the Vacuole is one centrally placed.

Animal Cell	Plant Cell
4. Tonoplast is absent.	4. The inner membrane (Tonoplast is present in the Vacuole.
5. Golgi bodies are present.	5. Golgi bodies are absent but in place of that dictyosomes are present.
6. Centrosome is present situated near the nucleus.	6. Centrosome is absent.

Cell Division : Cell division is an important property of the living cell with the help of which one cell gives rise to a new cell of the similar type without losing any organelle or size. In ancient time, it was believed that a cell divides only after developing in size upto a certain limit but this theory was discarted on this basis that a cell can be expanded and can get that limit by getting ample amount of food material. Later another theory was suggested by modern scientists. According to this theory, a nucleus develops along with the cell. When the nucleus attains a certain limit, it divides. This theory was accepted by all.

The cell division is of three types *i.e.*, *Amitosis*, *Mitosis* and *Meiosis*. Amitotic cell division (*Fig. 2·13*) occurs in Protozoa and in early embryonic stages of Metazoa. In this type of division the nucleus divides first into two nuclei and then the cytoplasm divides with the result in both

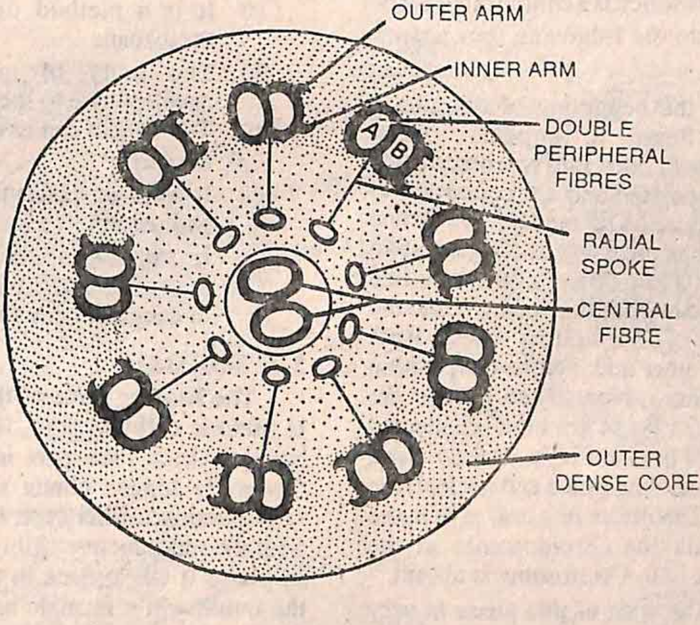
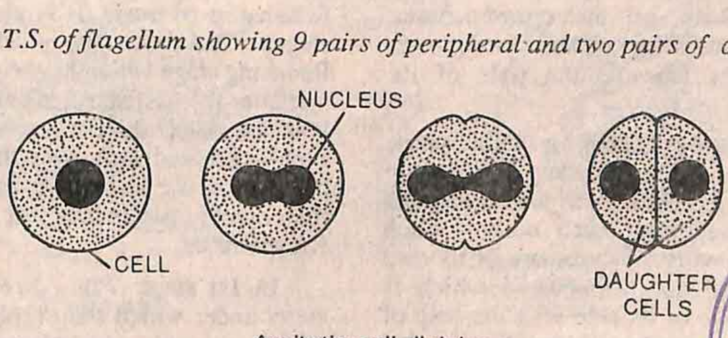


Fig. 2·12 T.S. of flagellum showing 9 pairs of peripheral and two pairs of central fibres.



Amitotic cell division

Fig. 2·13

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divisions a cell divides into two daughter cells. The nucleus of the Protozoan cell possesses chromatin granules. So all the daughter cells have no discrimination among themselves and with Parent cell.

The process of cell division is same in all types of division. In this process the nuclear division takes place first which is called *Karyokinesis*, then the cytoplasm divides which is termed as *Cytokinesis or Mitosis*.

2.2 MITOSIS:

This type of cell division is also called as *Mitotic cell division*. It occurs in the sometic cells of the body. The cell starts its division when it develops upto a certain limit. This process of development depends upon the physical and chemical factors. The period of the development upto a certain limit is called as Resting stage or Interphase. Then the Karyokinesis starts which is a complicated process and is divided into the following four phases (*Fig. 2.14*)

Prophase : In the beginning of this phase the chromosomes begin to appear. Each chromosome is already divided into two chromatids which are closely associated and are connected to each other at centromere. The nuclear membrane starts to disappear. The centriole divides into two groups. One group contains five hollow tube like structures which open at both the ends. While the other group consists of four hollow tubes. Both groups repel to each other and attains the position opposite to each other. Now these groups are called as Poles. These poles are inter-connected with the help of asters or astral rays. In later stage of this phase the nuclear membrane and nucleoli are totally disappeared. The asters or astral rays make their connection with the chromosomes at the centromere. In Plant Cell, Centrosome is absent.

Metaphase : The span of this phase is very short. In this phase, all the chromosomes assemble at the equator of the cell horizontally each chromatid is facing towards the pole of its respective sides.

Anaphase : In the beginning of this phase the centromere of each chromosome divides into two parts chromatids. Thus both the chromatids are completed apart from each other. Each chromatid is also having a centromere of its own so it is now called as chromosome which is connected to the pole of its side with the help of asters. These asters stretch with the result of that the freely suspended chromosomes first attain a 'V' shape and then 'J' shape.

Telophase : In this phase the chromosomes reach near the pole. The asters dissolve and the dissolved material is stored all around the pole. Now the nuclear membrane is again formed and the daughter nucleus is visible.

Cytokinesis : As soon as the daughter nucleus is formed the cell membrane starts depressing towards inner side from the middle of the cell. This depression increases gradually and ultimately divides the whole cell into two daughter cells. During this phase the cytoplasm is also divided equally into two halves. Thus two daughter cells are formed having equal number of chromosomes with their parent cell.

Mitotic cell divisions in plant cell and animal cell can be summ arised as given in (Fig. 2·15).

Significance of Mitosis :

(*i*) It is a method of reproduction in the Protozoans.

(*ii*) The body of multicellular animals develops due to this cell division.

(*iii*) The wound can easily heal due to this cell division.

(*iv*) It helps in repairing the pre-existing cells and tissues.

(*v*) It maintains the law of genetics by maintaining the number of chromosomes in daughter cells and the parent cell.

2.3 MEIOSIS

The another name of this type of cell division is Meiotic cell division. It occurs in those living beings which take part in sexual reproduction. Generally higher plants and animals do sexual reproduction. This type of cell division occurs with the reproductive cells of reproductive organs. In plants it takes place in the anther lobes and in the ovule while in male animals in testes and in females in ovaries. It is also completed in two stages. The first stage is called Meiotic stage or Reducing stage while the second stage which starts just after the first stage, is called Mitotic stage. In both the stages the process steps are similar with each other and also with the Mitosis *i.e.*, after completing the Interphase, Karyokinesis starts and then cytokinesis occurs just after completing the Karyokinesis.

In 1st stage (*Fig. 2·16*) the Karyokinesis starts under which the Prophase takes place first which is very complicated but important.

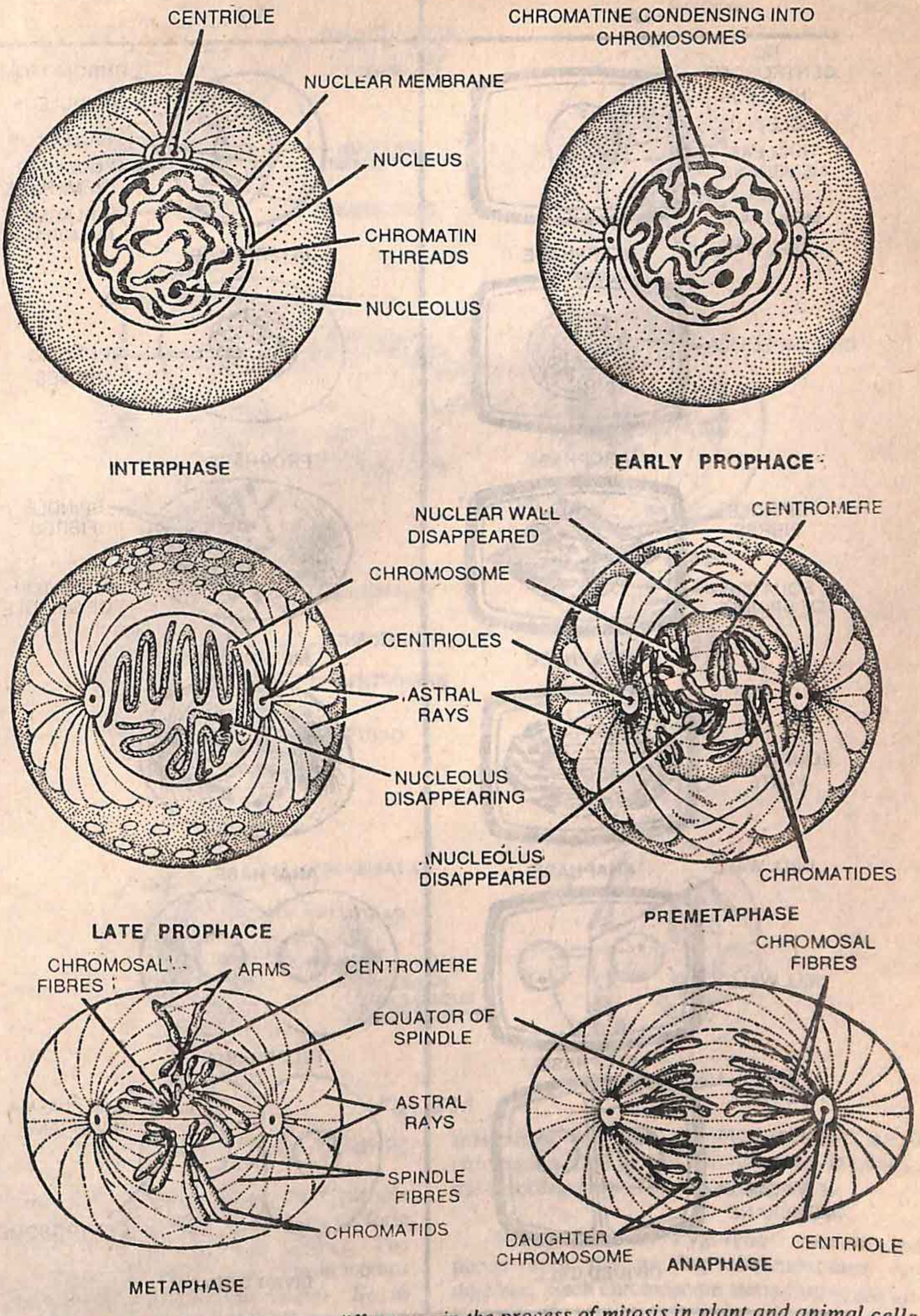


Fig. 2·14 Diagram to illustrate differences in the process of mitosis in plant and animal cells.

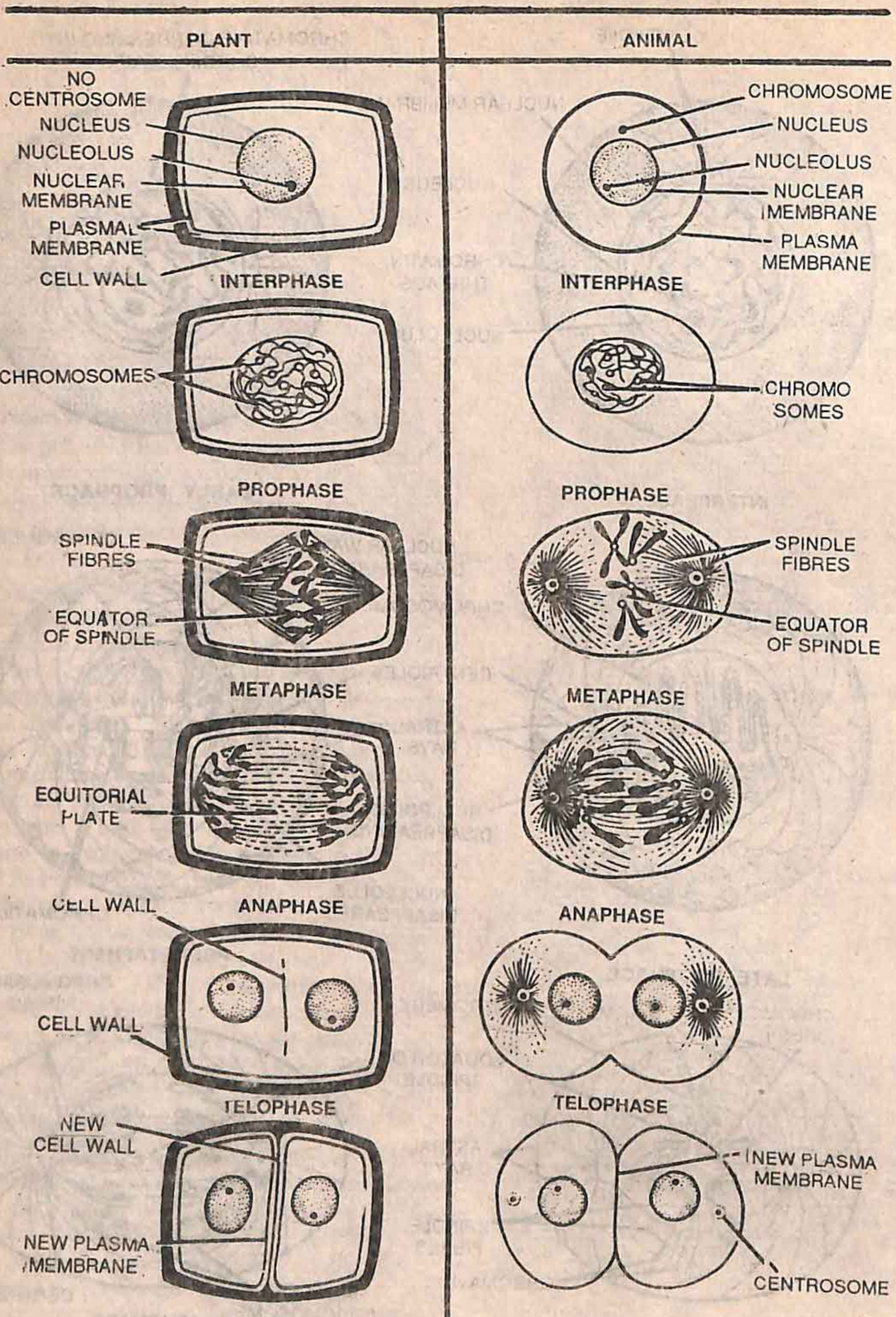


Fig. 2·15. Diagram to show various stages of mitosis.

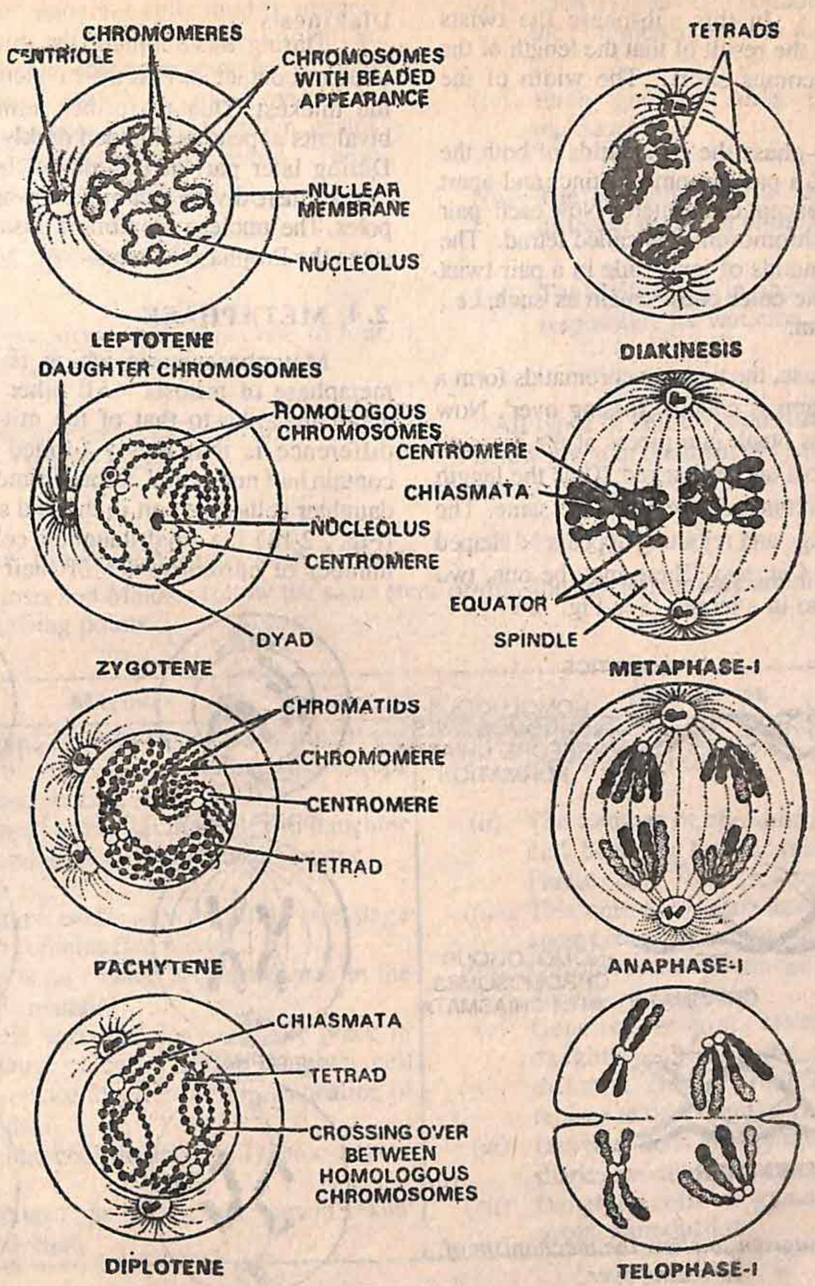


Fig. 2·16

Prophase I is further divided into the following sub-phases :

Leptotene : In this sub-phase the Centriole starts dividing into two groups which later on form poles. The chromosomes become distinct. The nucleus contains half number of chromosomes from father and half number from mother. So, in this stage one male and one female chromosomes come closer to each other to form a pair. At this stage both the chromosomes act as the chromatids. This pair of chromosomes is called as the homologous pair of chromosomes.

Synaptotene or Zygotene : In this sub-phase both the pairing chromosomes twist together. Each chromosome starts further dividing into two chromatids. Twisting chromosomes are connected together at many places.

Pachytene : In this sub-phase the twists come closer with the result of that the length of the twisting pair becomes short. The width of the synapt increases.

In this sub-phase the chromatids of both the chromosomes of a pair become distinct and apart from each other except centromere. Now each pair of homologous chromosomes is called tetrad. The Non sister chromatids of inner side in a pair twist together while the outer ones remain as such, *i.e.*, in untwisted form.

In this subphase, the twisting chromatids form a cross. This position is called 'crossing over'. Now these chromatides break into pieces at the crossing place. These pieces are exchanged. Thus the length of the twisting chromatides remains the same. The point of interchange and rejoining appears '×' shaped and is known as *Chiasma*. There may be one, two or more chiasmato in a tetrad. (See Fig. 2·17)

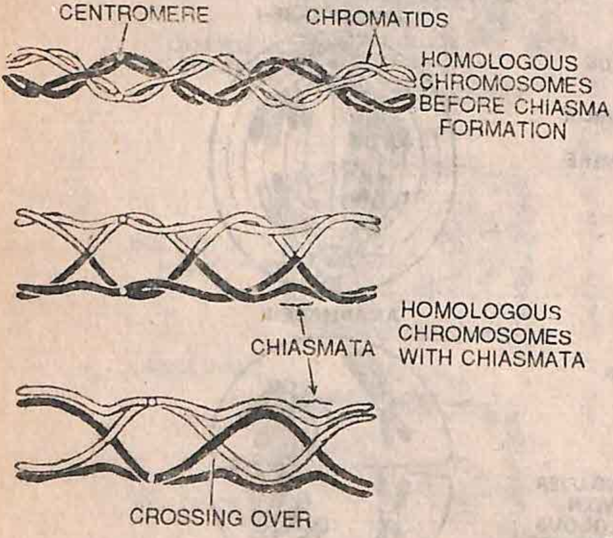

CENTROMERE
CHROMATIDS
HOMOLOGOUS CHROMOSOMES BEFORE CHIASMA FORMATION
CHIASMATA
HOMOLOGOUS CHROMOSOMES WITH CHIASMATA
CROSSING OVER

Fig. 2·17. Diagram to show the mechanism of crossing over.

Diplotene :

In this Subphase, both the homologous chromosomes uncoil and apart from each other but these remain in contact on chiasmata. The chromosomes become shorter and thicker by coiling and the chiasmata move away from the centromere and approach the ends. This phenomenon is known as 'terminalization'.

Diakinesis :

During this Subphase the chromosomes continue to contact so that the bivalents may become the thickest. Due to further terminalization the bivalents appear as rounded darkly stained bodies. During later part of this phase the centriole and centrosphere divide and move towards the opposite poles. The nuclear membrane disappears. At this stage the Prophase is over.

2.4 METAPHASE

Metaphase starts which is similar to the metaphase of mitosis. All other phases of first stage are alike to that of the mitosis. Only the difference is that newly formed daughter cells contain half number of chromosomes, so when these daughter cells take part in the 2nd stage of division (Fig. 2·18) the final daughter cells contain half number of chromosomes of their grand parents.

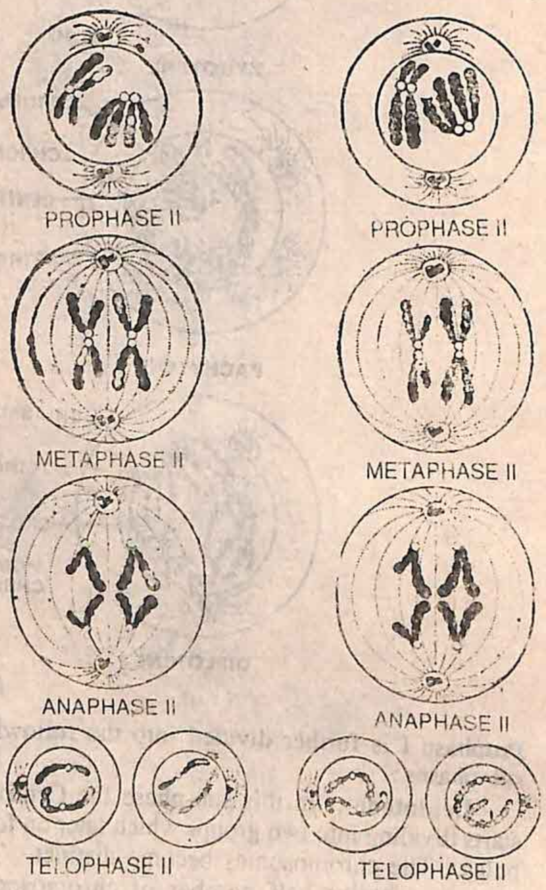

PROPHASE II
PROPHASE II
METAPHASE II
METAPHASE II
ANAPHASE II
ANAPHASE II
TELOPHASE II
TELOPHASE II

Fig. 2·18 Different stages in the second meiotic cell division in an animal cells.

The newly formed daughter cells modify in their shape to attain a particular shape, known as gametes. In animals, the male gamete is called sperm while female gamete is called ovum. In plants the male gamete is called Pollen grains while the female gamete is called ovule. These gametes take part in sexual reproduction.

Significance of Meiosis :

(*i*) Each reproductive cell gives rise to four daughter cells.

(*ii*) Each daughter cell is modified and is called as male / female gamete.

(*iii*) Each daughter cell contains half number of the chromosomes from that of Parent cell.

(*iv*) Each gamete takes part in sexual reproduction.

(*v*) The chromosomes of the offspring are different from that of the Parents.

(*vi*) The difference in the chromosomes is responsible for variation.

All types of cell divisions can be summarised as below given in the form of chart.

The difference between Mitosis and Meiosis :

Though Mitosis and Meiosis follow the same steps of division, even then they are different from each other on the following points :

Mitosis	Meiosis
(*i*) This type of cell division occurs in all the cells of the body (Somatic cells) except reproductive cell.	(*i*) This type of cell division occurs in reproductive cells.
(*ii*) The number of chromosomes in daughter cells and Parent cell remains the same.	(*ii*) The number of chromosomes in daughter cell becomes half of the number of the Parent cell.
(*iii*) This type of division has only one stage which contains five phases.	(*iii*) This type of division has two stages. Each stage contains five phases.
(*iv*) There is no change or transference in the genetic material.	(*iv*) Chromosomal material is exchanged during crossing over.
(*v*) Genetic variation does not take place in the daughter cell. So the daughter cell may replace to parent cell as in healing of wounds.	(*v*) Genetic variation takes place in the daughter cell. So the daughter cell is different from Parent cell and cannot replace to the Parent cell.
(*vi*) Daughter cells do not modify their shape.	(*vi*) Daughter cells modify their shape and new shapes are called gametes.
(*vii*) Daughter cells do not take part in sexual reproduction.	(*vii*) Daughter cells or gametes take part in sexual reproduction.

The Importance of Crossing Over :

It is the basis of the variation in the offsprings. *During crossing over (Fig. 2·17) the exchange of chrosomal material in the male and female gametes takes place with the result of that the offspring contains some characters of mother and some characters of father.* These characters are carried by genes. Genes are the parts of chromosomes and are responsible for hereditary traits (Fig. 2·19). They go from parents to the offspring. Therefore, the children of the same parents resemble each other and yet are different. The reason of the variation in the children is the gene combination in the gametes.

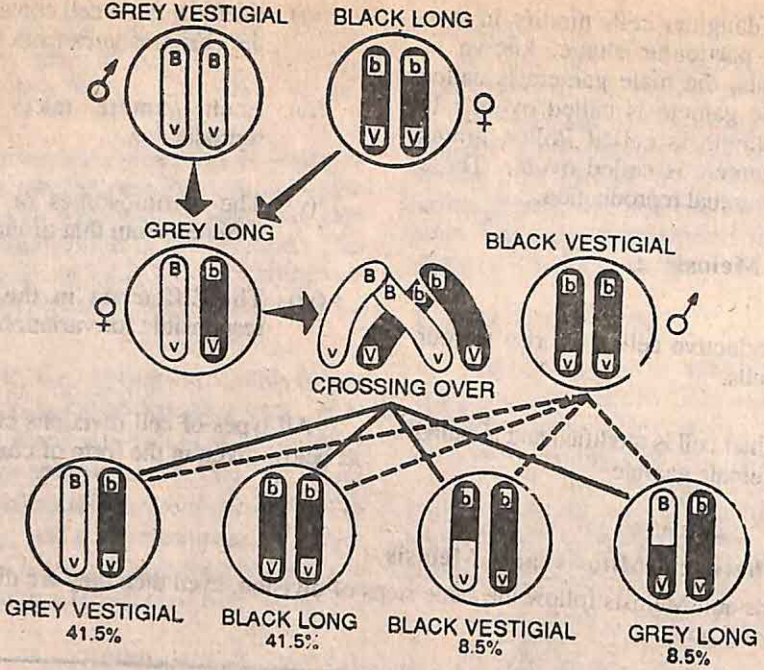


Fig. 2·19. Crossing over in Drosophila.

Identical twins have no variation in the traits. A fertilized egg after some cell division, bifercates into two embryos which develop by mitotic cell division. They will have the same chromosome sets. Therefore this pair of twins will show similarities in all traits *i.e.,* they will be of the same sex. There may be more than two identical offsprings which are very rare in human beings but is very common in other animals like rats, cats, dogs etc. (See Fig 2.20). These are called as Monozygotic twins.

Fraternal twins are those, which are non-identical. Such twins are the result of the simultaneously fertilization of two ova separately by two separate sperms. As both the zygotes have different sets of chromosomes, so both have different genetic characters. Their sex may be different. These twins are called as Dizygotic twins.

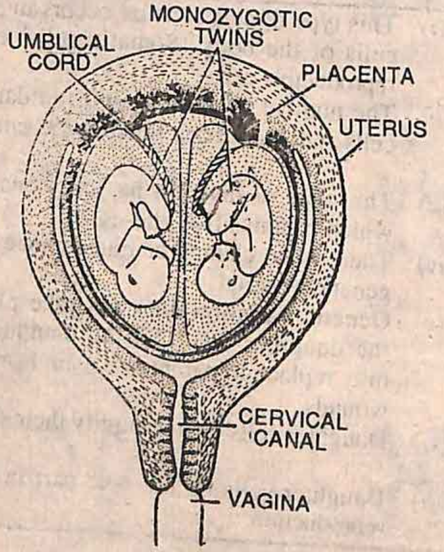


Fig. 2·20 Development of a monozygotic twin.

SUMMARY

1. The organisation of the parts is essential for every organism to survive.
2. Individual is the common property among all the organisms. This level is termed as the 'organismic level'.

3. Organic level is based on the simplicity to complexity.

4. The lower level of hierarchy starts from complex to the simple *i.e.,* from individual to the fundamental elements like Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulphur.

5. The higher level of hierarchy also starts from individual and ends upto the Biosphere like individual, population, species, ecosystem and Biosphere.

6. The cell is the structural and functional unit of life. Every living's body is made up of cell or cells.

The new cell is originated from the pre-existing cell.

The structure of cell : Plant and animal cells consist of cell wall, cell membrane, cytoplasm, Nucleus, golgi bodies, mitochondria, ribosomes, lysosomes, endoplasmic reticulum vacuoles etc.

Cell Division : It is the important property of the living cell with the help of which one cell gives rise to a new cell of the similar type. The cell division is of three types :

(*i*) Amitosis, (*ii*) Mitosis and (*iii*) Meiosis.

In all types of cell division the nucleus divides first which is called '***Karyokinesis***' and then cytoplasm divides which is called '*cytokinesis*'. Karyokinesis is completed into four phases — Prophase, Metaphase, Anaphase and Telophase.

In meiosis, the Prophase-I is further divided into the following sub-phases—Leptotene, Synaptotene or Zygotene, Pachytene, Diplotene, Diakinesis. In mitosis each parent cell gives rise to two daughter cells while in meiosis each parent cell gives rise to four daughter cells which modify into gametes.

Crossing over is a stage in the Pachytene subphase in meiosis in which two homologous chromosomes of a pair interchange their parts.

Significance of mitosis and meiosis.

QUESTIONS

1. Define the following terms :

(*i*) Tissue (*ii*) Population (*iii*) Biosphere (*iv*) Organism (*v*) Chromosome.

2. Give answer of the following in one word or in one sentence :

(*i*) What is the correct term used for the group of similar animals taking part in reproduction and increasing their number ?

(*ii*) What is the term used for the organelle providing the energy to the cell ?

(*iii*) What is the term used for the cells of the whole body in multicellular animals except the reproductive organs ?

(*iv*) What is the name of the locomotory organ in Amoeba ?

(*v*) What is the scientific term used for the four chromatids in a group in Prophase I in Meiosis ?

3. Distinguish between the following :

(*i*) Mitosis and Meiosis
(*ii*) Prophase in Mitosis and Prophase in Meiosis
(*iii*) Community and Biome
(*iv*) Centrosphere and Centromere
(*v*) Haploid and diploid
(*vi*) Animal cell and Plant cell
(*vii*) Organ and organelle
(*viii*) Identical and Fatemal twins.

4. Complete the blanks in the following :

(*i*) ? → Prophase → Metaphase → ? → Telophase → Cytokinesis.

(*ii*) Leptotene → ? Pachytene → Diplotene → ?

(*iii*) Organism → ? → Community → ? →Biosphere

(*iv*) Atoms → ? → Cell → ? → Organ → ? → ?

5. What are the roles of the following :

(*i*) Plasma membrane (*ii*) Vacuole (*iii*) Mitochondria (*iv*) Centrosome (*v*) Ribosomes (*vi*) Chloroplast (*vii*) Chromosomes (*viii*) Nucleolus

6. How will you justify the following statements :

(*i*) "A cell is a structural and functional unit of the living organism."

(*ii*) "An organism cannot survive alone."

(*iii*) "Sexual reproduction is impossible without Meiosis in Higher animals."

7. Give answer of the following in 50-60 words :

(*i*) Importance of mitosis

(*ii*) Significance of Meiosis

(*iii*) Importance of crossing over in Meiosis

(*iv*) Importance of Interphase

8. Draw the labelled diagrams of the following :

(*i*) Structure of a typical cell seen under electron microscope.

(*ii*) Different stages of Mitosis.

(*iii*) Different stages of Prophase I of Meiosis.

❑ ❑

CHAPTER 3
LIFE PROCESSES – I

LEARNING OBJECTIVES :

At the completion of this Chapter, you should be able to learn

1. The meaning of Physiology. It is one of the essential vital activities.
2. Nutrition — its types, *i.e.* , (A) Autotrophic (B) Heterotrophic.
3. Photosynthesis — It is also a vital process during which the green plants prepare their own food.
4. Heterotrophic Nutrition—In this type, the animals are dependent on the autotrophs directly or indirectly.
5. Types of heterotrophs — Saprophytes, Parasites (Endoparasite and Ectoparasite) holozoic.
6. There are four main steps of holozoic nutrition, *i.e.,* Ingestion, digestion, absorption and egestion.
7. Respiration — Its definition, importance for living organisms. Mechanism of respiration which involves three main steps — Inhalation, exchange of gases and exhalation.
8. Types of Respiration — (*i*) Aerobic respiration (*ii*) Anaerobic respiration.
9. You will be able to differentiate the breathing from respiration and burning from respiration.
10. You will understand diffusion, osmosis and ascent of sap. You will also learn the mechanism of opening and closing of stomata.
11. You will understand the meaning and importance of circulatory system in human beings.
12. You will learn the structure and functions of blood, blood vessels (arteries and veins), heart and lymph. The difference between blood and lymph.
13. Excretion — its meaning, importance, types and mechanism.

INTRODUCTION

Anybody can be called as living body only when it performs certain vital functions for maintaining its existence in the universe. Vital functions are Nutrition, Respiration, Excretion, Transportation, Reproduction, Growth, Development etc. All living beings have to perform all such activities though their mode of doing such activities may be different. The branch of Biology which deals with such vital activities is called as Physiology. In this Chapter all such vital and physiological activities will be discussed one-by-one.

3.1 NUTRITION

Every living being requires energy to perform all the vital activities which is obtained from the food. So food is required by all living beings and is consumed to release energy. This process is called *Nutrition.* There are mainly two modes of Nutrition *i.e.,* Autotrophic Nutrition and Heterotrophic Nutrition.

Autotrophic Nutrition : *Autotrophic nutrition is that in which the organism is independent for its food.* It prepares its food. Mostly green plants have such property to synthesise their own food during the process of the *Photosynthesis.* In green sulphur Bacteria the hydrogen is liberated from Hydrogen Sulphide (H_2S) instead of water (H_2O). Such process of preparing food is called *Chemosynthesis.* So both Photosynthesis and Chemosynthesis in the organisms are known as Autotrophs.

Photosynthesis : *It is a process during which the green parts of the plant are able to synthesize their food in presence of sunlight (solar or radiant energy) by taking carbon dioxide and water to give rise to Organic Compounds and free oxygen as a by-product (Fig. 3·1).*

The whole process is divided into two major stages :

The first stage starts in presence of sunlight. So it is called as Light Reaction. It was discovered by Robert Hill. So it is also named as Hill's Reaction. It is completed into two steps — the Photolysis and Photophosphorilation. In the beginning of the light reaction the solar energy emitting from the sun is received and collected by chlorophyll '*a*', one of the four chemical compounds of chlorophyll present in the chloroplast. This solar energy helps in splitting the water molecule into hydrogen ion (H^+) and hydroxyl ion (OH^-).

H_2O + Solar energy $\rightarrow H^+ + OH^-$.

These hydrogen ions reduce the enzyme NADP (Nicotinamide adenine dinucleotide Phosphate).

$NADP + 2H^+ \rightarrow NADPH_2$ (*See Fig. 3·2*)

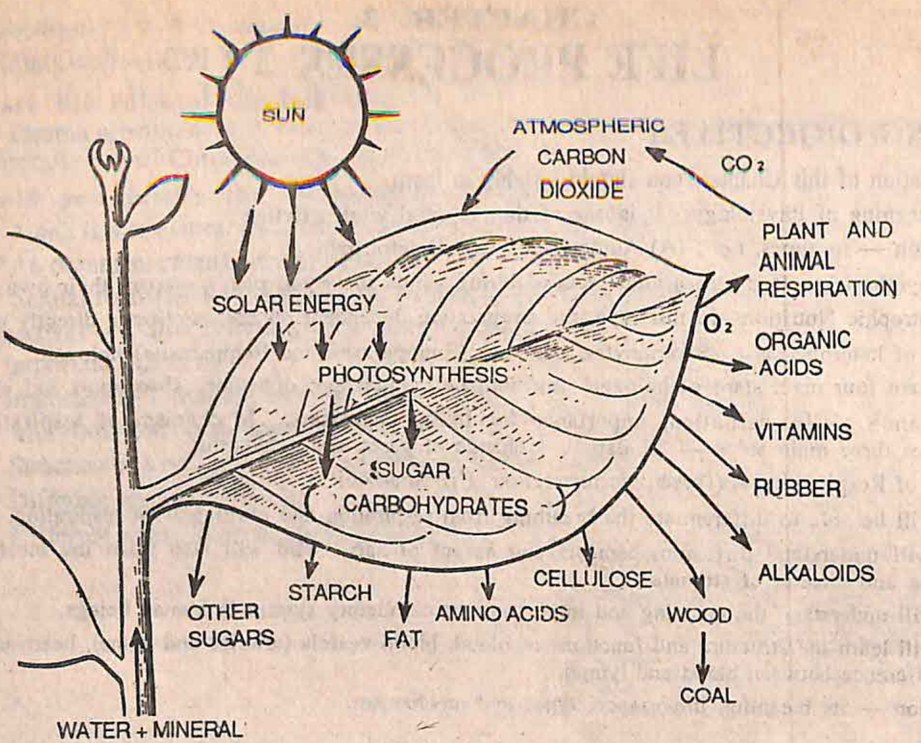


Fig. 3·1 Various products produced as a consequence of photosynthesis.

The negatively charged hydroxyl ions on coming in contact with the chlorophyll '*b*', give up their electrons and become free of charge. Now these hydroxyl radicals combine together to form water molecule and oxygen molecule which is liberated out.

$4\ OH^- \rightarrow 4\ e^- + 4\ OH$

$4e^- + \text{Chlorophyll } b \rightarrow \text{chlorophyll } b^-$

$4\ OH \rightarrow 2H_2O + O_2$

This process of catalysing the water in presence of sunlight energy or radiant energy is called as '*Photolysis*'. *[See Fig 3·2 (a)]*

In second step of Light Reaction, *i.e.*, *Photophosphorelation*, the high energy electrons present in chlorophyll *b* are used to combine with

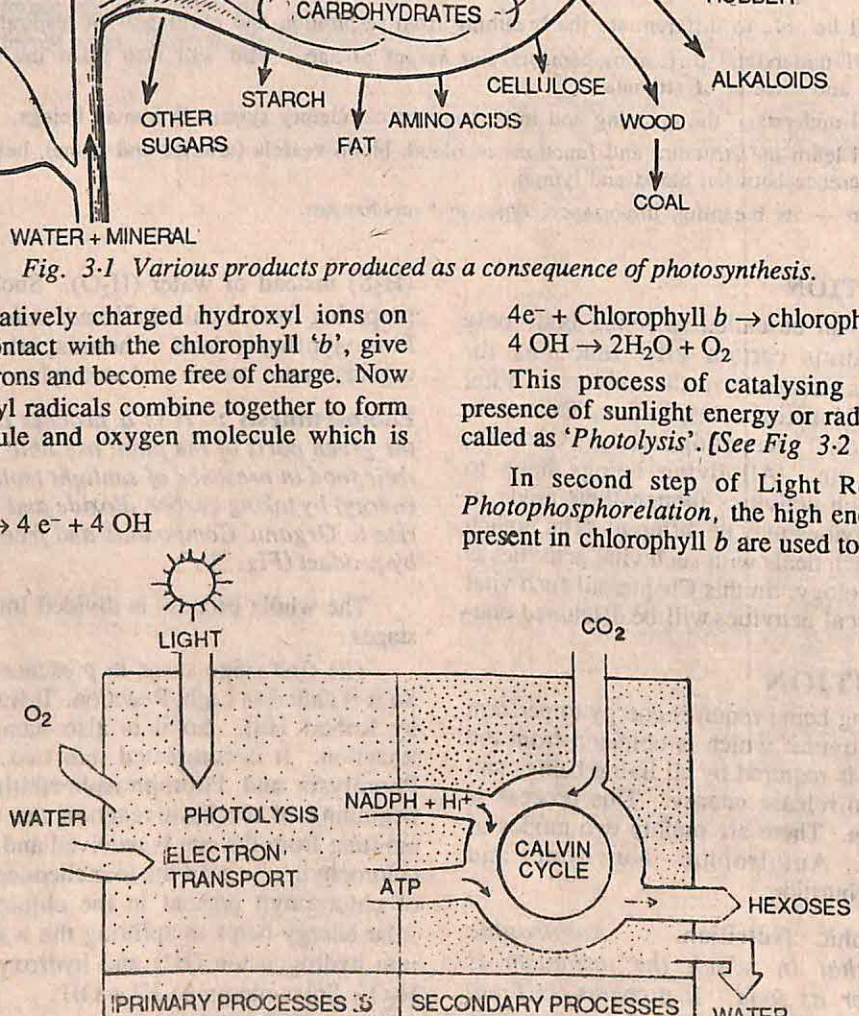


Fig. 3·2 (Light Reaction) (a) Photolysis.

inorganic phosphate (ip) and A.D.P. (Adenosine diphosphate to form ATP (Adenosine triphosphate) *[See Fig 3·2 (b)]*

$ip + ADP + e^- = A.T.P.$

The products of light reaction are used in the dark reaction.

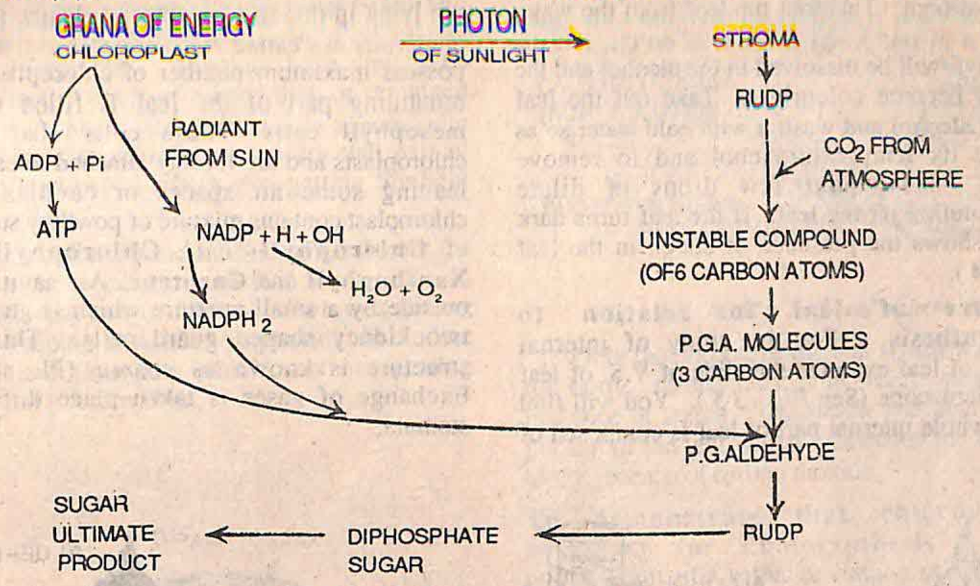


Fig. 3·2 · (b) Photophosphorelation.

Dark Reaction : It was discovered by a scientist named as Blackman. So it is named as *Blackman's reaction*. In this process, the stored energy of ATP is utilized in the decomposition of carbon dioxide into carbon and oxygen. The carbon (C^{12}) is converted into isotopic carbon (C^{19}) which is utilized in the reduction of 5 carbon sugar into 6 carbon compound which immediately splits into 3 carbon compound and then ultimately 6 carbon compound is formed. Thus dark reaction undergoes cyclic reaction which is known as '*Calvin Cycle*' (*Fig. 3·3*). During this process the ultimate product is starch, the complex form of Organic compound. It can be shown by a simple experiment.

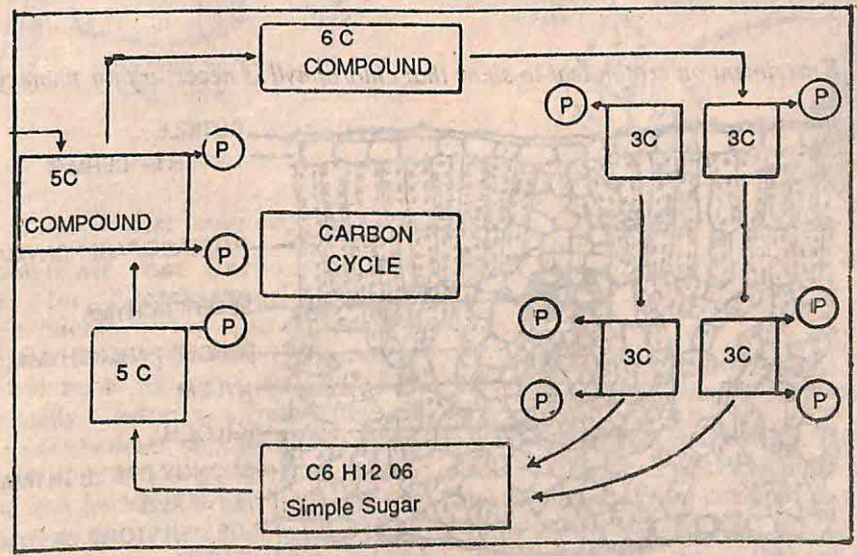


Fig. 3·3 Dark Reaction

Starch Test : Take a leaf of the plant to be tested. Boil it in water for five minutes so as to destroy the enzymes and to make the leaf softer and more absorbent. Take out the leaf from the water and put it in the Amyl alcohol at 60°C. All the chlorophyll will be dissolved in the alcohol and the leaf will become colourless. Take out the leaf from the alcohol and wash it with cold water so as to make its temperature cool and to remove alcohol. Now pour few drops of dilute iodine solution on the leaf. If the leaf turns dark blue, it shows the presence of starch in the leaf (*Fig. 3·4*).

Structure of leaf in relation to Photosynthesis : For the study of internal structure of leaf examine the slide of V.S. of leaf under microscope (See *Fig. 3·5*). You will find that the whole internal part of leaf is composed of mesophyll cells which are only of one type in monocot or isobilateral leaf but are of two types in Dicot or Dorsiventral leaf. One type of cells which are lying in one or two rows just below the upper epidermis are called *Palisade Cells*. These cells possess maximum number of chloroplasts. The remaining part of the leaf is filled with the mesophyll cells. These cells also contain chloroplasts and are loosely attached to each other leaving some air spaces or cavities. Each chloroplast contains mixture of powdery substances of **Chlorophyll '*a*', Chlorophyll '*b*' Xanthophyll** and **Carotene**. Air cavities open outside by a small aperture which is guarded by two kidney shaped guard cells. This whole structure is known as *stoma* (Pl. stomata). Exchange of gases is taken place through the stomata.

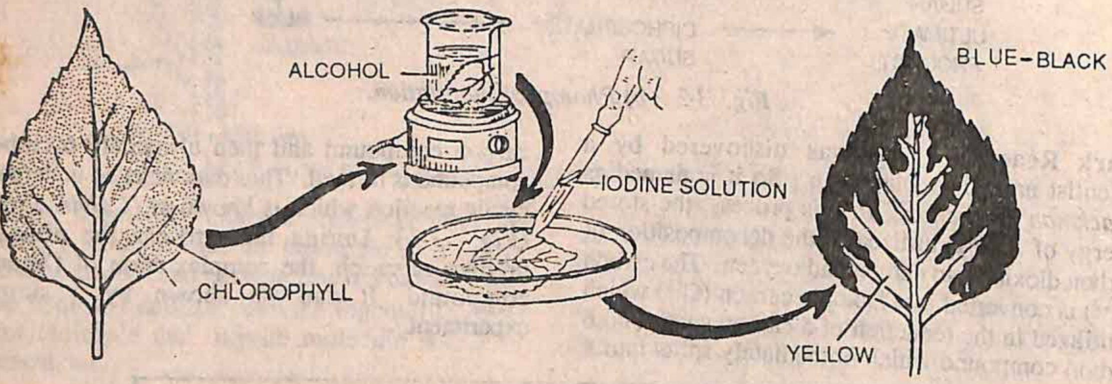


Fig. 3·4 Experiment on croton leaf to show that chlorophyll is necessary for photosynthesis.

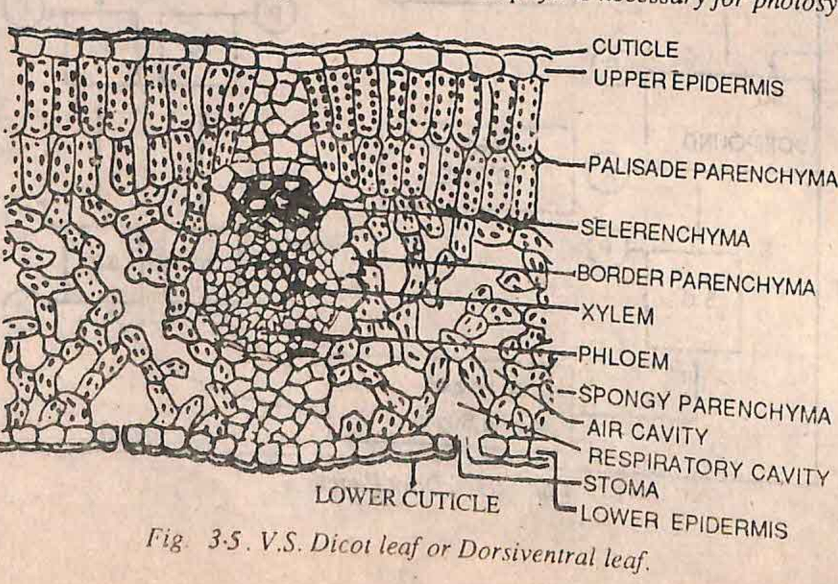


Fig. 3·5 . V.S. Dicot leaf or Dorsiventral leaf.

To demonstrate that light is necessary for Photosynthesis : Take a fresh leaf detached from the plant in the water before Sun rise. Fix it in Ganong's light screen apparatus as shown in Fig. 3·6. The leaf base should be dipped in the water of a Petri dish or remained attached with plant. Keep the whole apparatus in Sunlight for 4 or more hours. Mark that part of leaf with lead pencil which was getting Sunlight (*See Fig. 3·6*).

After a definite period in Sunlight, take out the leaf from the apparatus and test for starch. In starch test, that part of the leaf which was getting Sunlight become dark blue on pouring dil. Iodine solution and that part which was not getting Sunlight did not turn blue.

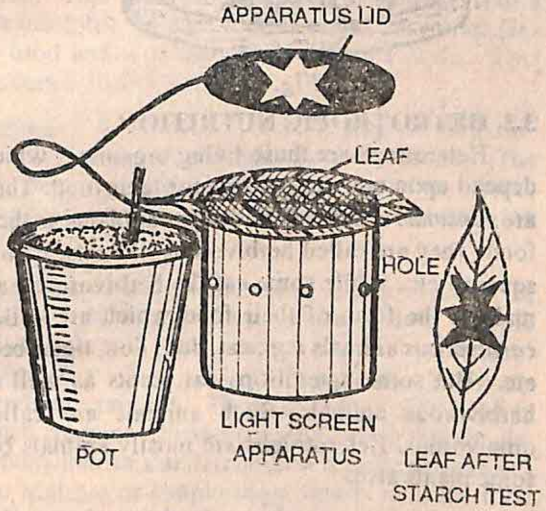


Fig. 3·6. Ganong's light screen apparatus.

To demonstrate that Carbon Dioxide is necessary for Photosynthesis (Moll's half-leaf experiment) : Take a small quantity of freshly prepared lime water or KOH solution in a wide mouthed bottle as shown in Fig. 3·7. Keep it horizontally. Now take a freshly plucked leaf. Fix the leaf in between both the halves of the cork and insert it in the mouth of the bottle in such a way that anterior half leaf should be inside the bottle and the free end of the petiole should be outside the bottle in the water. Place the whole apparatus in the Sunlight.

After a fixed time, take out the leaf from the bottle and test it for starch.

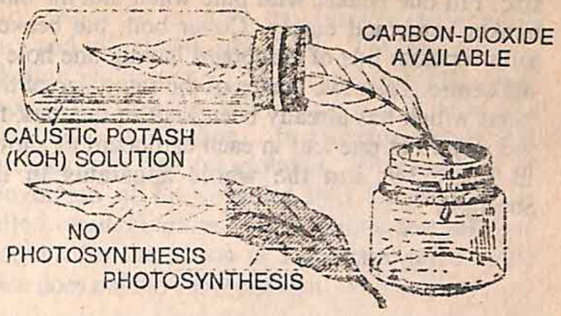


Fig. 3·7. Moll's half-leaf experiment.

Only the portion of the leaf which was outside the bottle, turned dark blue which indicates the presence of starch. The starch was absent in that portion of the leaf which was inside the bottle due to the absence of carbon dioxide.

To demonstrate that chlorophyll is necessary for Photosynthesis : Take a potted plant of Croton or Pathos or Colius (The leaves of these plants are varigated). Mark the white or of other colour spots other than green with lead pencil. Place the potted plant in the sunlight for sufficient time *(See Fig. 3·8)*.

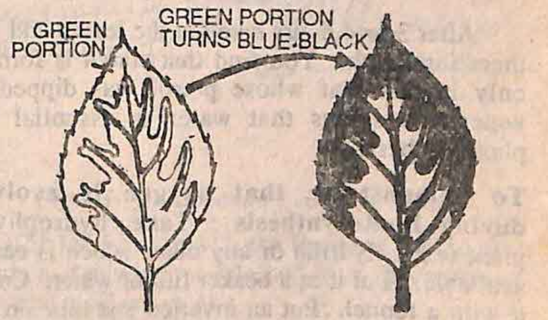


Fig 3·8. A variegated leaf of Croton to show clorophyll is essential for photosynthesis.

Then pluck a leaf from the plant and test it for starch. The green parts of the leaf turned dark blue while the parts of other colour or white do not turn blue which indicates that Photosynthesis occurs only in the green parts of the plant or leaf.

To demonstrate that water is essential for Photosynthesis : Take two beakers of equal size. Fill one beaker with pure water and the other beaker remained empty. Cover both the beakers with separate lids of cardboard having one hole in the centre. Take two leaves of the same size of that plant which has already been kept in the dark for 2-3 days. Fix one leaf in each cardboard as shown in Fig. 3·9. Put the whole apparatus in the Sunlight.

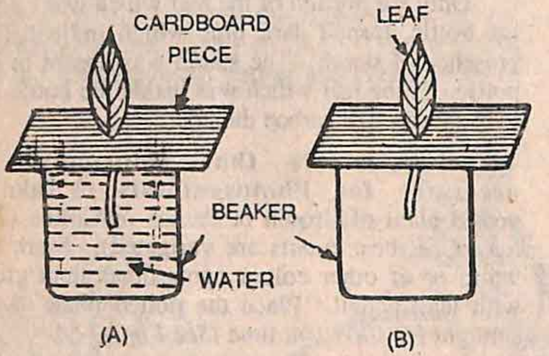


Fig. 3·9. Water is essential for photosynthesis

After 3 or 4 hours take out the leaves and test them for starch. You find that starch is formed only in that leaf whose petrol was dipped in water. It shows that water is essential for photosynthesis.

To demonstrate that oxygen is evolved during Photosynthesis : Take hydrophytic plant (*e.g.*, Hydrilla or any other which is easily available). Put it in a beaker full of water. Cover it with a funnel. Put an inverted test tube on the stem of the funnel full of water as shown in *Fig. 3·10.*

Put the whole apparatus in the Sunlight. After a certain period you find that gas is evolving from the plant in the form of bubbles which are collecting in the upper part of the test tube by the displacement of water. Thus fill 3 or 4 test tubes with the gas and then test the gas. For the test of the gas take a burning splinter in or near the test tube it burns with fast speed and with high flame. This shows that plants evolve oxygen gas during Photosynthesis.

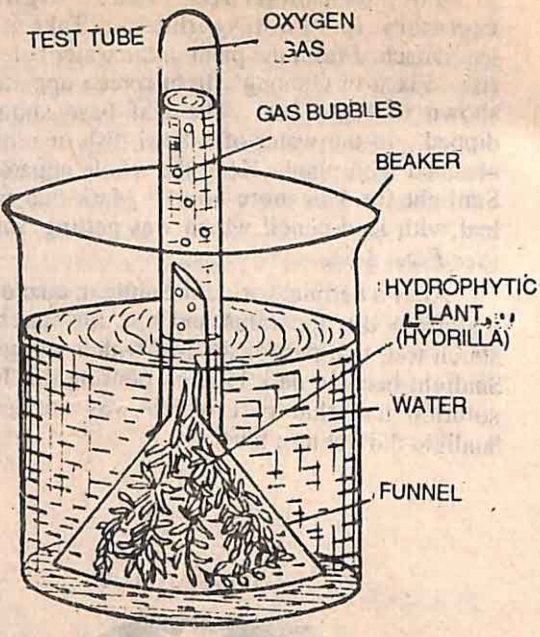


Fig. 3·10.

3.2 HETROTROPIC NUTRITION :

Heterotrops are those living organisms which depend upon other organisms for their food. They are *consumers*. Some heterotrops eat plants as their food. They are called herbivorous like rats, rabbit, squarrel etc. While some eat the herbivorous animals in the form of their food which are called *carnivorous* animals *e.g.*, cat, dog, lion, tiger, bear etc. But some heterotrops eat plants as well as herbivorous animals. Such animals are called omnivorous. Heterotrophs are mostly animals but some plants also.

Heterotrophs can derive food in two ways *i.e.*, either from dead and decaying bodies are called saprophytes or from living organisms that it kills or eats.

Saprophytes: A saprophyte is that organism which derives its food from the rotten plants and decaying organic matter. Yeast moulds, mushrooms, many bacteria etc., or saprophytes. These plants analyse the dead complex organic material into simple ones for their food but the simple remaining material is used as manure for the growing plants.

Parasite : Parasites are those living organisms which depend on other living organisms for their food. They are further classified into Actoparasites and Endoparasites.

Actoparasites are those which make contact with the other living's body or host's body externally for their food. They are generally temporary parasites *e.g.*, lice, bedbugs, leech, mosquitoes, wasps, etc. Endoparasites are those which make contact internally with the host's body for their food as well as shelter, *e.g.*, Entamoeba, Tapeworm, Ascaris, Pinworm, some type of bacteria.

Holozoic : The living organisms feed on the solid food material are called holozoic. Man and higher animals come under this category. In this type of nutrition the food is first of all taken inside the body through mouth. This process is called *Ingestion*. Then it is converted into simple and soluble form with the help of some enzymes present in the digestive juices. This process is called *digestion*. Then the soluble essential elements are absorbed by the walls of alimentary canal. This process is called *Absorption*. While the insoluble form of food is called the waste part of food and it is taken out from the body. This process is called *Egestion*.

Ingestion : This is the first step of holozoic nutrition which is generally done by mouth. The big pieces of food are broken into fine pieces mechanically by teeth grinding or mestication process.

Digestion : Digestion means the conversion of complex insoluble form of food into simple soluble form. This process starts from buccal cavity (*Fig. 3·11*), where three pairs of salivary glands are present. These glands produce saliva which contains *salivary amylase* which convert the carbohydrate or starch (complex organic compound) into Maltose or simple sugar that is why the food becomes sweet in taste on mestication. It is then engulfed into the stomach passing through the Pharynx and oesophagus where no digestion take place.

In stomach, the food is grinded by the mucosae villi by peristaltic movement. During this process the gastric juice is released from the gastric glands. This juice contains *hydrochloric acid* and *pepsin enzyme*. Hydrochloric acid plays an important role in digestion. It makes the food acidic, destroys the diseased bacteria, does not allow the food to be rotten and does not allow the food to be quickly digested. Now the acidic medium is favourable for the activity of pepsin which now converts the Protein of food into peptone. Now the food is passed on to the small intestine or ileum. The anterior part of ileum is called duodenum. When the food reaches in this region immediately the *bile juice* comes out from the gall bladder through bile duct and mixes with the food. The bile juice is alkaline in nature. So its role is also very important. It neutralises the acidity of food and then make it alkaline. It also breaks the fat particles into fine fat globules. This process of conversion of fat particles into fat globules is called *emulsification*. It provides the alkaline medium for the action of Pancreatic juice. Bile juice does not have any enzyme.

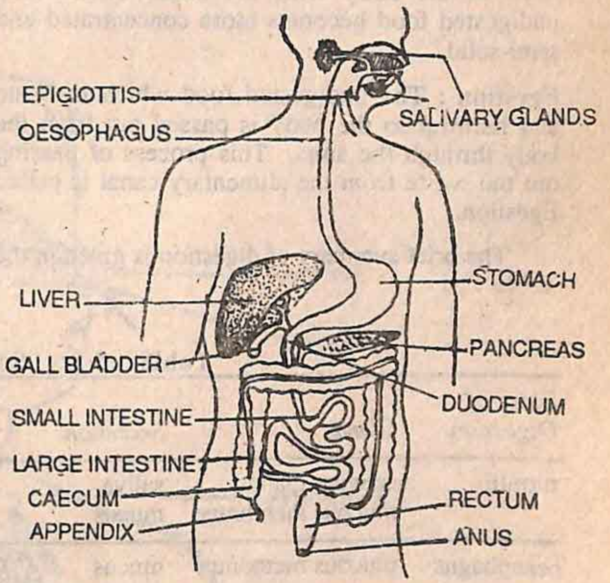


Fig. 3·11. Alimentary canal of Man

The food mixes with the Pancreatic juice also in this region which is released from Pancreas and has three main enzymes :

(*i*) **Trypsin :** Which converts the peptones into amino acids which are the simple and soluble forms.

(*ii*) **Amylopsin :** It converts the starch into sugar which is also soluble in water.

(*iii*) **Steapsin or Lypase :** It converts the fat globules into fatty acids and glycerol.

Now the food moves forward in the small intestine where it meets with another juice *i.e.*, Intestinal juice, secreted by the inner wall of the small intestine. It contains many enzymes which convert the remaining parts of the food elements into soluble form.

Absorption : The food is now completely in soluble form. The fatty acid and glycerol are absorbed by the inner wall of small intestine which is modified internally into finger-like projections called villus (Plu. villi.) and are sent to the lymph vessels while the amino acids, glucose, water and other soluble substances are sent to the blood vessel (*See Fig.* 3·12). These substances are distributed to all parts of the body. The remaining part of food is the undigested which is pushed ahead into the large intestine where the water present in the food is absorbed by the walls according to the need of the body with the result of that the undigested food becomes more concentrated and semi-solid.

Egestion : The undigested food which is waste and harmful to the body is passed out from the body through the anus. This process of passing out the waste from the alimentary canal is called Egestion.

The brief summary of digestion is given in the Table 3·1.

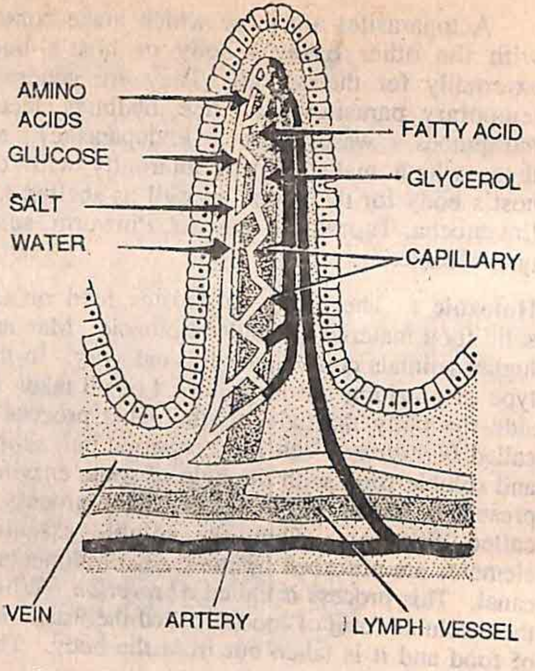


Fig. 3·12. Absorption of digested food in intestine.

Table 3·1. Summary of Digestion

Place of Digestion	*Glands*	*Secretion*	*Enzymes*	*Digestive Activity*
mouth	salivary glands	saliva	ptyalin	changes starch to maltose, lubricates
	mucous membrane	mucus		lubricates
oesophagus	mucous membrane	mucus		lubricates
stomach	gastric glands	gastric fluid	pepsin	changes proteins to peptones and proteoses
		hydrochloric acid		activates pepsin; dissolves minerals; kills bacteria
	mucous membrane	mucus		lubricates
small intestine	liver (Hepatic cells)	bile	–	emulsifies fats; activates lipase
	pancreas (Pancreatic cells)	pancreatic fluid	trypsin	changes proteins, peptones and proteoses to peptides
			amylase	changes starch to maltose
			lipase	changes fats to fatty acids and glycerin
	intestinal glands	intestinal fluid	erepsin	changes peptides to amino acids
			maltase	changes maltose to glucose
			lactase	changes lactose to glucose and galactose
			sucrase	changes sucrose to glucose and fructose
	mucous membrane	mucus		lubricates
large intestine (colon)	mucous membrane	mucus		lubricates

3.3 RESIPRATION

Respiration is a vital activity which is done by all the living organism. In this process the food is broken down into simpler forms and energy is liberated. Food of the animals is the part of the plants containing energy in the form of complex organic substances like carbohydrate, protein, fat etc. This energy can be utilized by the animal body only when the food is analysed or transformed into simple compounds and energy. This conversion of complex compound into simple compounds and energy is possible only in presence of oxygen. It can also be said that the energy present in the food material. Respiratory substrate can be released only by oxidation of food. This oxydation process is not a vigorous process and the whole energy present in the respiratory substrate does not release at once. It releases gradually which is supplied to the cells where it is consumed in the vital activities. This process of breaking down the respiratory substrate is called catabolism.

The whole process of respiration is done in three main steps — Inhalation, Exchange of gases and Exhalation. There are many organs which are associated with this process and are constituting a system known as *Respiratory system (Fig. 3·13)*. These organs are — **nasal chamber and nasal openings, respiratory duct, bronchii, bronchioles, capillaries, a pair of lungs and diaphragm.**

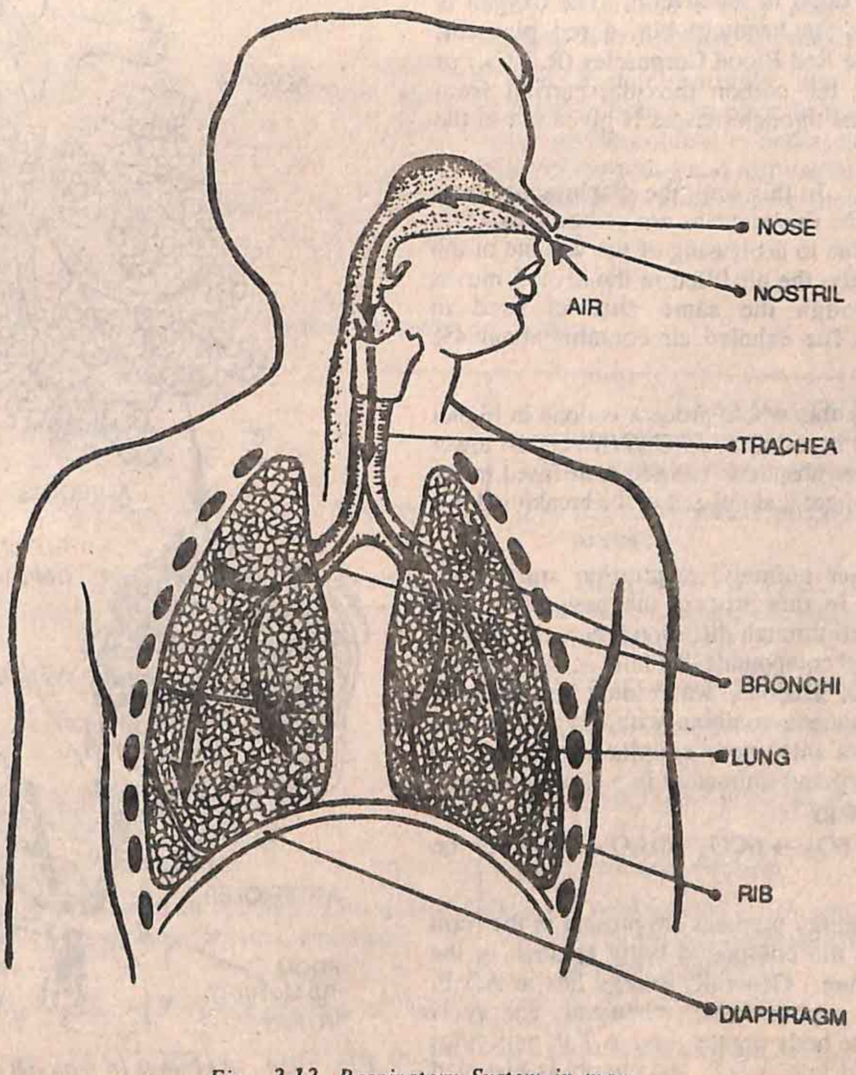


Fig. 3·13. Respiratory System in man.

Inhalation : In this step the diaphragm moves upward with the result of that the thoracic ribs expand and the inner volume of thoracic cavity increases. The air already present inside the lungs exerts less pressure than outside so the outer atmospheric air rushes in through the external nostrils which reaches in the alveoli of the lungs passing through the respiratory duct bronchii, bronchioles and capillaries. The inhaled air contains about 0·03% CO_2.

Exchange of gases : There is a network of blood capillaries lying in between the outer and inner walls of the alveoli *(Fig. 3·14)*. The wall of blood capillaries are very thin and their thickness is supposed to be the negligible. So it is presumed that blood comes in direct contact with the air filled in the alveoli. The oxygen is absorbed by the haemoglobin, a red pigment, present in the Red Blood Corpuscles (R.B.Cs.) of blood while the carbon dioxide, carried from various organs through plasma is given out in the alveoli.

Exhalation : In this step, the diaphragm moves downward, the thoracic ribs are compressed (*Fig. 3·14*) and due to decreasing of the volume of the thoracic cavity, the air filled in the alveoli moves outside through the same channel used in inhalation. The exhaled air contains about 4% CO_2.

Actually this whole process is done in higher animals and is called as *BREATHING*. In lower animals the atmospheric oxygen is diffused in the body cells where it is utilized in the breaking down of food.

In higher animals, respiration starts after breathing. In this process the oxygen reaches inside the cell through diffusion where the soluble forms of food compounds like fatty acids, glycerol, amino-acids, glucose, water etc., are present. These compounds combine with oxygen and are broken down into more simpler compounds in step-wise-step and ultimately into carbon dioxide, water and energy.

$C_6 H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 38$ A.T.P. or 2830 KJ.

These energy particles are present in the form of bonds in the compound lying as such in the cells for future. Generally energy lies in A.T.P. (Adenosine triphosphate), whenever, energy is needed by the body organs these A.T.P. molecules are converted into A.D.P. and energy is liberated A.T.P. → A.D.P. + ip + e^- (energy).

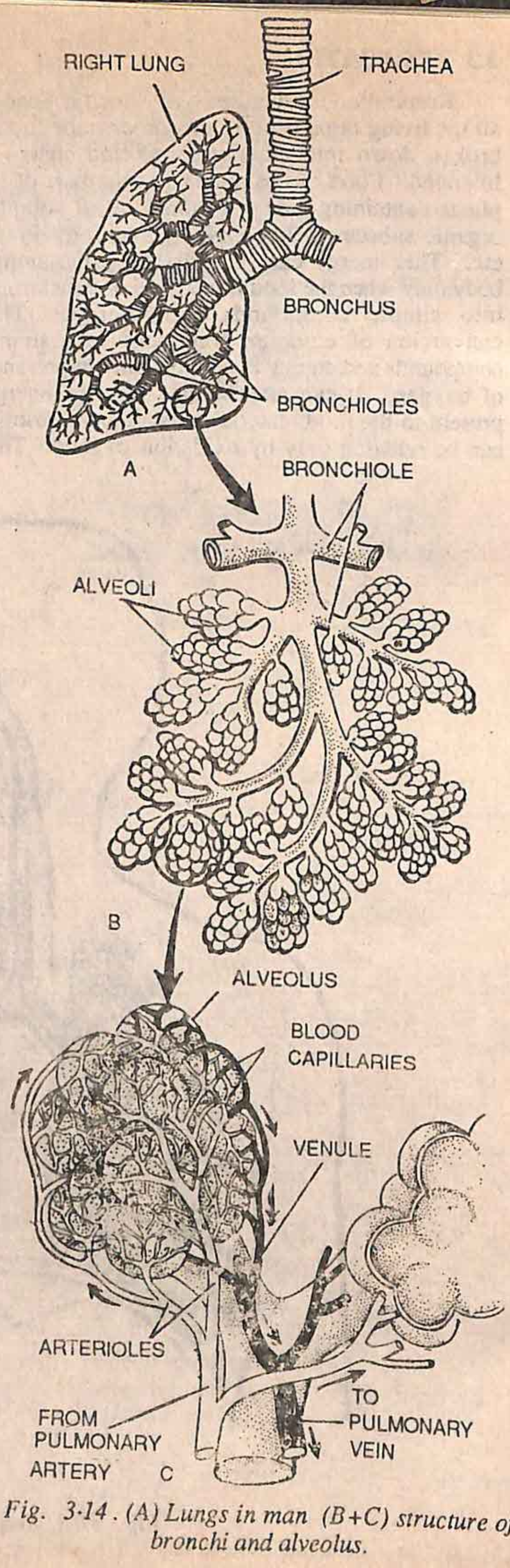


Fig. 3·14 . (A) Lungs in man (B+C) structure of bronchi and alveolus.

From Mitochondria of the cell are meant for respiration process. Several enzymes are located in the mitochondria which are used in respiration. Mitochondria are bag-like structures floating in the cytoplasm of the cell and are generally known as the power-house of the cell.

Thus breathing is a physical process while respiration is a chemical process. The total oxydation of breaking down of glucose is completed into two steps. The first step is completed in the absence of oxygen (*Anaerobic respiration*) in which the glucose is partially broken down into ethyl alcohol or lactic acid and similar compounds alongwith a small quantity of energy

$C_6 H_{12} O_6 \rightarrow 2\ C_3 H_6 O_3$ + energy (e^-)
(glucose) (Lactic acid)

The above reaction occurs in the muscles of higher animals and also in bacteria. While in yeast, the glucose is broken down into ethyl alcohol, carbon dioxide and energy which is 54 K. cals.

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + e^-$
(glucose)→(ethyl alcohol) + carbon + (54 K.cals)
energy energy

The second step of respiration is completed in presence of oxygen. So it is called as *aerobic respiration*. In this stage, the incompletely broken molecule of glucose undergoes complete oxydation into carbon dioxide and energy. One molecule of glucose produces energy which is equal to 38 molecules of A.T.P.

$2C_3 H_6 O_3 + 6O_2 \rightarrow 6\ CO_2 + 6H_2O$ + energy (38 A.T.P.)

In plants the mechanism of respiration is much simpler than that of animals. In them, the atmospheric air is diffused in the plant body through stomata and lenticels which reaches in the intercellular spaces and then in the cells where it is utilized in breaking down the food material into CO_2, water and energy under the process of respiration as discussed in animals.

In higher animals, the breathing and respiration both take place in the body regularly. Some people confuse to understand the difference between breathing and respiration. They generally speaking respiration to the breathing and vice-versa.

The main differences between breathing and respiration are as below :

BREATHING	RESPIRATION
(*i*) It is a physical process.	(*i*) It is a biochemical process.
(*ii*) It is confined only upto exchange of gases.	(*ii*) It is complicated process (Biological oxidation).
(*iii*) This process takes place in the lungs so only the organs of the respiratory system are used.	(*iii*) This process takes place in the cells of different parts of the body (it is intra-cellular process).
(*iv*) Energy is not released.	(*iv*) Energy is released in the form of A.T.P.
(*v*) Enzymes are not required.	(*v*) Several enzymes are involved in this process.
(*vi*) It does not take place in microbes and other lower animals.	(*vi*) It takes place in all the living beings.
(*vii*) It is a quick process.	(*vii*) It is a slow process.
(*viii*) It is completed into three stages *i.e.,* Inhalation Exchange of gases and Exhalation.	(*viii*) It is completed in two stages *i.e.,* Glyodysis and Anaerobic respiration or Aerobic respiration.
(*ix*) Energy is required in conducting this process.	(*ix*) Energy is released in this process.

RESPIRATION	BURNING (COMBUSTION)
(*i*) It takes place only in the living cells.	(*i*) It does not take place in the living cells.
(*ii*) Food (Respiratory substrates) is oxidised in steps with the result of that energy is liberated.	(*ii*) Fuel substances are oxidised at random and energy is liberated.
(*iii*) Energy is liberated in less quantity but for a long time which is utilized by the organs in activities.	(*iii*) Energy is liberated in large quantity at one time which can be utilized within the limited time.
(*iv*) No flame appears.	(*iv*) Flame can be appeared alongwith the liberation of energy.
(*v*) Evolved energy can be stored in the form of A.T.P. which can be utilized as and when it is required by the body cells.	(*v*) The evolved energy cannot be stored for future.
(*vi*) Intermediate temporary compounds are formed.	(*vi*) No intermediate compounds are formed.
(*vii*) Several enzymes are utilized in this process.	(*vii*) There is no need of enzymes for this process.
(*viii*) It takes place at ordinary temperature.	(*viii*) It takes place at a definite temperature which is called as optimum temperature.

AEROBIC RESPIRATION	ANAEROBIC RESPIRATION
(*i*) It takes place in presence of oxygen.	(*i*) It takes place in the absence of oxygen.
(*ii*) CO_2 is produced in large quantity.	(*ii*) CO_2 is produced in less quantity.
(*iii*) Glycolysis which occurs in cytoplasm and then the other aerobic step occurs in mitochondria.	(*iii*) Glycolysis and the other step occur in cytoplasm.
(*iv*) In this process glucose is completely oxydised into CO_2 and H_2O.	(*iv*) In this process glucose is incompletely oxidised and gives out Ethyl alcohol (Ethanol) and CO_2.
(*v*) Energy, produced from one gram glucose is 2830 KJ or 38 A.T.P.	(*v*) Energy, produced from one gram glucose is 54 K.cals.

3.4 INTERNAL TRANSPORT OF MATERIAL

The digested form of food will be utilized only when it reaches at proper place in the body of the organism. In the same way, the excretory material, produced in various organs can be excreted out only through those organs which are ment for the excretory function. Such organs are called the excretory organs. These organs will excret the waste and harmful substances only when they will be received by them. Thus the process of sending the material from one place to the other place is called Transportation. There are three main states of material *viz.*, solid, liquid and gas. Various methods of transportation are found in various animals and their principles are the same. Generally **Diffusion** and **Osmosis** are the two main methods which are found in lower and higher organisms. In higher animals and plants, the substances are carried by some media in definite channels.

Diffusion : *Diffusion is a process of movement of molecules from the region of higher concentration to the region of lower concentration till the concentration becomes equal in both the sides (Fig. 3·15).*

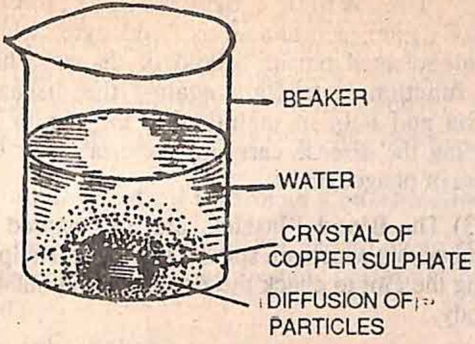


Fig. 3·15 . Diffusion.

This process, no doubt is faster in gases than in liquid and solids but also depends upon the nature of the substances and the size of the molecules. In lower animals like Amoeba and Paramecium, in lower plants like chlamydomonas, Bacteria etc., and in some multicellular animals like Hydra Earthworm and also in multicellular plants like Spirogyra, Ulothrix, Rhizopus etc. Food materials and oxygen gas enter the body through diffusion and carbon dioxide and other metabolic wastes come out from the body through the same process.

In the green leaves, the CO_2 is diffused in during Photosynthesis and is fixed in the form of carbohydrate which acts as a diffusion gradient between the air and the intercellular spaces with the result of that the CO_2 diffusion is continued from the atmosphere towards the leaf. In the same way, the oxygen, produced inside the leaf during Photosynthesis, is passed out forming an oxygen gradient in the direction opposite to that of CO_2. Diffusion takes place in all the direction from the surface that is why the larger area will be more useful for this process.

Osmosis : It is another form of diffusion in which two solutions of different concentrations are separated by means of semipermeable membrane the solution of low concentration moves towards the solution of high concentration.

In the higher plants and animals their body need is too much which cannot be met out by diffusion process. That is why, there are special vessels for transport.

"Transport of material in Plants": In plants xylem and phloem are the two main vessels through which the material in the form of solution is carried. The movement of the solution is done by a special process done in the stomata of the leaves. *Stomata are the tiny apertures present on the surface of the leaves.* Each stoma is guarded by two guard cells which contain the cytoplasm and the solution too *(Fig. 3·16)*. Each stoma opens and closes which depends on the internal pressure or turgor pressure exerted on the walls. Light intensity and loss of water are also two main factors that control the opening and closing of stomata. Gaseous exchange in the leaves are done through the stomata.

Opening of Stomata : During photosynthesis, the concentration of sugar increases in the guard cells and other cells of the leaf which causes the change of osmotic pressure or the turgor pressure. It causes the guard cells to curve and open the stomata.

Closing of Stomata : When the sugar concentration decreases the osmotic pressure decreases in the guard cells with the result of that the guard cells lose water and dilute solution and become straight due to which the inner side walls come closer to each other closing the stomatal aperture (*Fig. 3·16*).

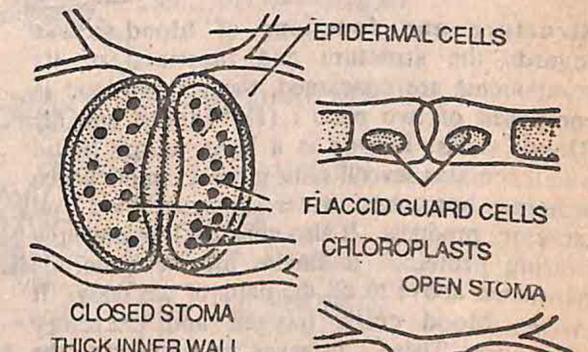


Fig. 3·16 . Diagram showing opening and closing of stomata.

The transport of water and other dissolved sugar along with other substances in the plant body is done by two processes named as *Translocation* and *Transpiration*. The former process is that in which the sugar and other substances, in the form of solution, passes to various parts of the plant body.

Transpiration is that process in which the water in the form of vapours are passed out in the atmosphere and the subsequent movement of water and other substances takes place in the xylem vessels. Thus mineral salt and water in the form of solution is taken from the soil and is sent upto the top parts of the plant through xylem vessels while the prepared food material in the form of solution is sent to various parts of the plant through Phloem vessels.

3.5 BLOOD CIRCULATION

Blood circulation is the transport system of animals. It is present in all the higher animals and few lower animals like Earthworm.

The whole blood circulatory system includes heart, Blood vessels and Blood.

Blood : Blood is a fluid connective tissue which is red, granular and concentrated liquid and acts as the medium for transporting the food, hormones, enzymes, water, respiratory substance, excretory matter etc.

Structure and functions of blood : As regards the structure and functions of its components are concerned, the whole blood is composed of two parts : (1) **Plasma** and (2) **Blood Cells.** Plasma is a light yellow liquid which contains several salts, glucose, amino acids, proteins, hormones, water, digested food and excretory products. It also contains Fibrinogen, a clotting protein. It carries all the materials mentioned above to all the parts of the body. It carries blood cells, oxygen and excretory substances. These substances are supplied to the concerning organs. It also helps in healing the wounds where fibrinogen is separated out from the plasma in the form of fibrin, while the remaining part of plasma is called as serum. Blood cells are also called as Blood corpuscles. These cells are of three types —

(1) The **Red Blood Corpuscles (R.B.Cs.)** which are spherical, non-nucleated and biconcave in the human beings. They are red due to the presence of haemoglobin, a special type of protein. They are about 4 to 4·5 millions in one cubic centimetre of blood in woman and 4·5 to 6·0 millions in one cc of blood in man. They carry oxygen and supply it to the cells of various organs of the body. They are also named as erythrocytes.

(2) The **White Blood Corpuscles (W.B.Cs.)** are also named as Leucocytes which are uninucleated but amoeboid in shape. Their main function is to fight against the diseased bacteria and help in maintaining the health by engulfing the disease carrying bacteria under the process of phagocytosis.

(3) The **Blood Platelets** are also named as Thrombocytes which are spindle shaped and help in healing the clot to check the flow of blood outside the body.

Functions of Blood : Blood performs the following functions in the body :

1. Transport of Oxygen :

Blood transports the oxygen from lungs to the tissues of the body. This function is performed by the red blood corpuscles. These cells contain haemoglobin that combines with oxygen to form oxyhaemoglobin.

Haemoglobin + Oxygen $\rightleftharpoons$ Oxyhaemoglobin.

They receive the oxygen from the walls of alveoli of lungs. This oxyhaemoglobin again converts into oxygen and haemoglobin when it comes in contact to the tissue. The oxygen is diffused inside the cells of tissue where it is utilized in the process of Respiration. Now the blood becomes De-oxygenated.

2. Transport of Carbon Dioxide :

Carbon dioxide is a byproduct of the process of respiration which is diffused out from the cell of the tissue as soon as the blood comes in contact with the tissue. Plasma of the blood carries the CO_2 and releases in the excretory organs like lungs, liver, skin etc., from where it is removed from the body.

3. Transport of Nutrients :

Digested food material in the form of glucose, amino acids, vitamins, mineral salts and water are transported by the blood to various tissues of the body.

4. Regulation of Body Temperature :

Blood comes in contact to all the cells of all the tissues of all the organs in the whole body. So it receives heat or energy where it is produced in excess and gives to that where it is needed or less and thus it equalises the temperature of the whole body.

5. Protection from Disease :

Blood also receives the diseased bacteria and other foreign substances present in any part of the body. The white blood corpuscles or cells capture by phagocytosis and make them uneffective. In this way they protect the body from the disease.

6. Maintenance of PH Hydrogen Concentration

It maintains the body PH according to the requirement. The plasma protein performs this function.

7. Supply of Water :

Blood plasma carries water and supplies it to various organs of the body and also receives it from where it is in excess. Thus it also helps in maintaining the equalization of water quantity in all the parts of the body according to their need.

8. Healing of Wounds :

Blood plasma and the thrombocytes (blood platelets) perform this function. As blood reaches to the wounded part, the Fibrinogen protein of blood plasma is converted into fibrin which makes the network over the whole wound. The thrombocytes get entangled in this network. Thus a clot is performed which protects the wound from the outside attacks and also protects its own loss.

9. Chemical Co-ordination :

Blood transports hormones and several other chemicals taken by the organism in the form of medicine to various organs of the body.

10. Maintenance of Body Pressure :

It maintains the body pressure, equalises it in all the organs of the body. The body pressure is equal to the atmospheric pressure. If the inner pressure is more, the body will burst and the organism will die. If the innner pressure is less, the body will be compressed and the normal functions will be stopped.

Blood vessels : Blood vessels are the special ducts through which the blood is transported. These vessels are of two types – (1) *Artery* (2) *Vein (See Fig. 3·17)*. Artery is that blood vessel which carries blood from heart to various organs. Vein is that blood vessel which collects blood from the organs and carries it to the heart directly or indirectly.

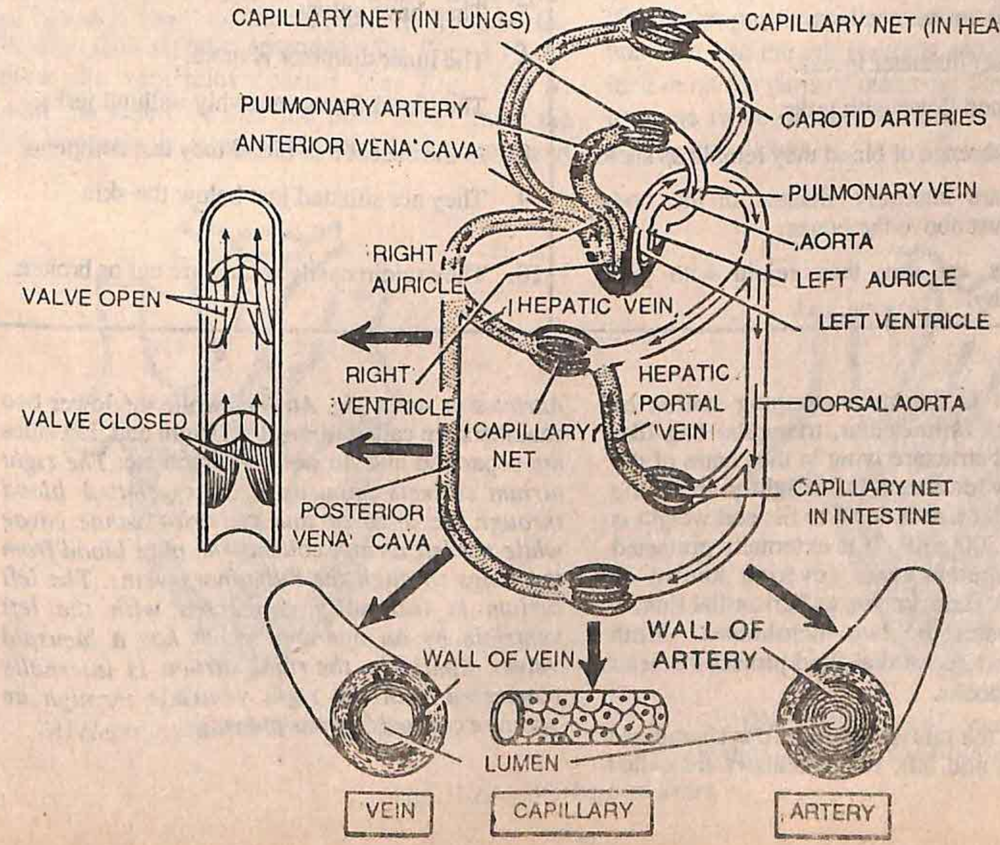


Fig. 3·17. Network of blood Capillaries

Capillary is the fine duct which carries blood to the cell of all the tissue, and also collects. The main arteries are divided into branches which further divide into thin tubes called arterioles. Each arteriole is further divided into thinner ducts called capillaries. The walls of capillary are permeable to water and to small molecules, oxygen and CO_2. These gases are of such mode that the alveoli of the lung pick up and expel air. The blood capillaries present in the liver are so thin that they make contact with every cell of the liver and transport the material.

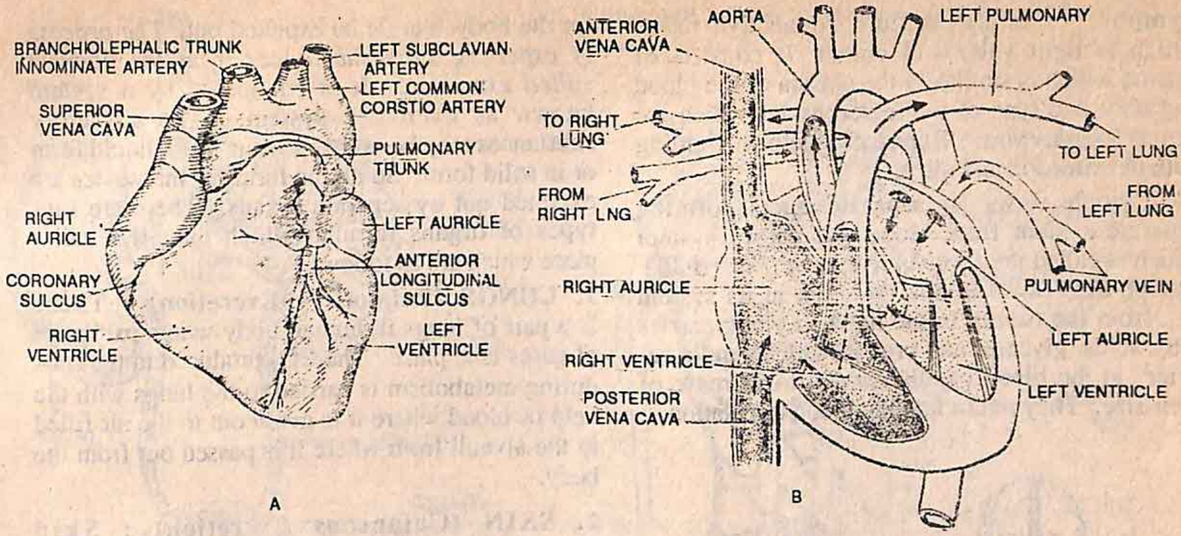
The cells of a tissue, are no doubt, arranged closely to each other but every cell is surrounded by a network of blood capillaries which are of two types. The capillaries which supply blood to the cell are called *arterioles* while the capillaries collect the blood are called *venules* which combine to other neighbouring venules to form thick branch named as vein which join to other veins of other organs and ultimately form a main vein through which the blood returns to the heart. Thus arteries supply the blood to the tissues while the veins collect the blood from the tissues.

Some identifying points between Artery and Vein are as follows :

ARTERY	VEIN
1. Artery carries blood from heart to various organs.	1. Vein carries blood from organs to the heart.
2. Pure blood flows in them except pulmonary artery in which impure blood flows.	2. Impure blood flows in them except pulmonary vein in which pure blood flows.
3. They are bright red in colour.	3. They are bluish red in colour.
4. They are thick-walled.	4. They are thin-walled.
5. They do not have valves.	5. They have valves.
6. The inner diameter is less.	6. The inner diameter is more.
7. The blood flows with jerks.	7. The blood flows smoothly without jerks.
8. In the absence of blood they remain as such.	8. In the absence of blood they can compress.
9. They are interiorly situated in the body lying just above the bones.	9. They are situated just below the skin.
10. If they are cut, they rejoin with great difficulty.	10. They rejoin easily if they are cut or broken.

Heart : It is the main pumping station of the blood which is muscular, triangular bag-like (Fig. 18·18) red structure lying in the centre of the thoracic cavity deviated left slightly from the posterior end. Its size is equal to fist and weight is approximately 300 gms. It is externally protected by a double membranous covering known as *Pericardium.* A fluid, known as Pericardial fluid is filled in between the two membranes. Both *Pericardium* and pericardial fluid protect the heart from external shocks.

Internally, the human heart is four chambered the upper right and left, two chambers are called *Auricles or Atria* (*Sg. Atrium*) while the lower two chambers are called *ventricles.* Right and left sides are separated and do not communicate. *The right atrium collects impure or deoxygenated blood through the anterior and posterior vanae cavae while the left atrium collects the pure blood from the lungs through the Pulmonary veins. The left atrium is internally connected with the left ventricle by an opening which has a bicuspid valve. Similarly the right atrium is internally connected with the right ventricle through an aperture covered by tricuspid valve.*

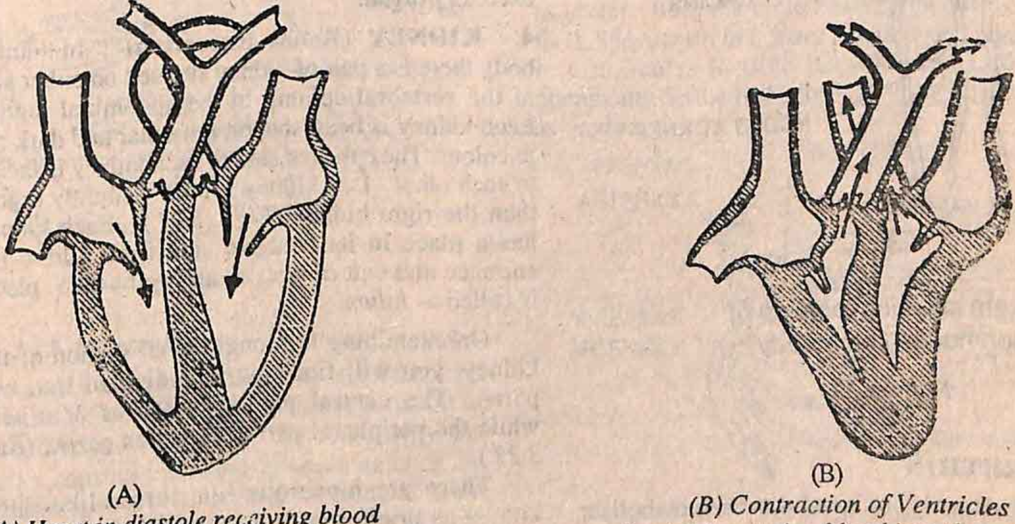


A. External Structure

B. Internal Structure

Fig. 3·18. Structure of human heart

Circulation of blood : In human body there is double circulatory system. At first the impure blood is collected in right atrium through venae cavae and the pure blood is collected in the left atrium through the Pulmonary veins. Both types of blood is sent into the left and right ventricles through their separate apertures. *(See Fig. 3·19 A)*. Now the ventricles contact *(See Fig. 3·19 B)* with the result of that the pure blood from the left ventricle is thrown into the dorsal aorta and then other branch arteries for distributing in the whole body while the impure blood is thrown into the lungs with the help of pulmonary arteries, that is why they carry impure blood. Again the impure blood after purification comes back to the left atrium and then into the left ventricle and then it is distributed in all the parts of the body. Thus the blood has to come twice in the heart, that is why it is called double circulation.



(A) Heart in diastole receiving blood

(B) Contraction of Ventricles (systole) pumping blood into the arteries.

Fig. 3·19. Working of heart

Lymph : It is also a fluid connective tissue which is light yellow in colour. It consists of plasma which is similar to the plasma of the blood and only one type of white corpuscles which are called *lymphocytes*. These cells help in fighting with the infection and diseases.

Lymph flows in separate ducts forming separate system from blood circulatory system which is called the *Lymphatic system* (*Fig. 3·20*). Lymph also flows in one direction in its system *i.e.*, from the tissues to the heart. Lymph carries fatty acids, glycerol and protein which cannot re-enter in the blood capillaries due to increase of their size. They return into the blood circulation.

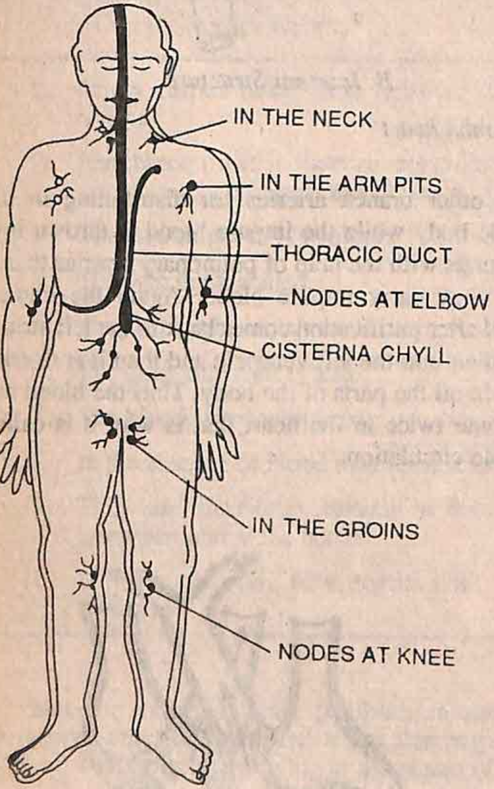


Diagram showing location of lymph nodes in the body

Fig. 3·20.

3.6 EXCRETION

The substances, produced during metabolism in the cells of the body which are harmful and waste for the body, should be expelled out. *The process of expelling such substances from the body is called excretion.* It is conducted by a system known as excretory system. The excretory substances may be in the gaseous form, liquid form or in solid form. So all the forms of the wastes are excreted out by separate organs. There are four types of organs through which excretion takes place which are as follows :

1. LUNGS (Pulmonary Excretion) : There is a pair of lungs in human body where exchange of gases take place. The CO_2 produced in the cells during metabolism is carried to the lungs with the help of blood where it is given out to the air filled in the alveoli from where it is passed out from the body.

2. SKIN (Cutaneous Excretion) : Skin also plays an important role in excretion. The ammonical salts and excess amount of water reach in the circulatory network lying in the skin along the blood from where they are filtered and collected by sebaceous glands which open outside the skin. The mixture of ammonical salts and water in these glands is called sweat which is excreted out from the body.

3. LIVER (Hepatic Excretion) : Liver does excretion indirectly. During metabolism, ammonia, the most injurious substance when carried to the liver through blood, the hepatic cells convert it into less harmful substances like urea, uric acid and ammonical salts etc., which are excreted out through kidney. Thus liver acts as the indirect excretory organ.

4. KIDNEY (Renal Excretion) : In human body there is a pair of kidney situated on either side of the vertebral column in the abdominal region. Each kidney is bean-shaped muscular and dark red in colour. The concave side of each kidney is facing to each other. Left kidney is placed slightly higher than the right kidney (*Fig. 3·21*). Each kidney has a place in its concave side from where the entrance and exit of arteries and veins take place, is called as *hilum*.

On examining the longitudinal section of the kidney, you will find that it is divided into two parts. The central part is called as *Medulla* while the peripheral part is called as *cortex* (*Fig. 3·22*).

There are numerous fine thread-like ducts known as uriniferous tubules or *Nephrons*, lying half in cortex region and half in Medulla region.

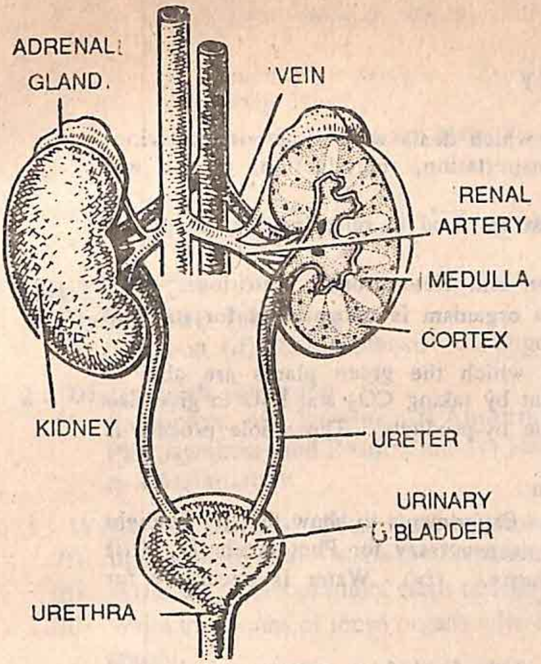


Fig. 3·21. Excretory organs of man.

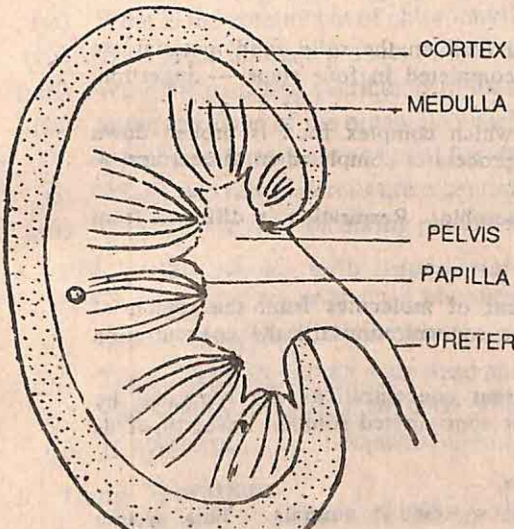


Fig. 3·22. Human Kidney – Internal structure

The free end of each nephron is cup-shaped known as *Bowman's Capsule* which contains a bunch of blood capillaries known as *glomerulus*. Now the Bowman's capsule including glomerulus is called Malpighian capsule. Glomerulus includes Afferent arterioles and Efferent arterioles. The tabular part of Nephron is divided into three parts *i.e.*, the *proximal — convoluted tubule, Henle's loop* and *distal convoluted tubule (Fig. 18·23).*

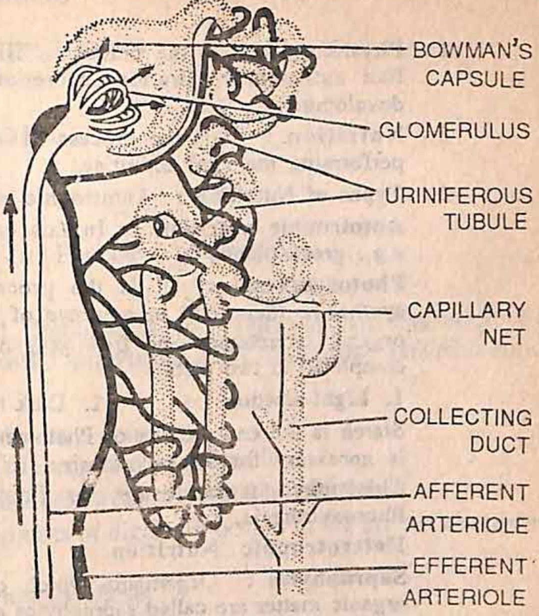


Fig 3·23 Structure of a nephron.

The excretory matter along with the amount of water is filtered from the blood in malpighian capsule but water is reabsorbed and is again filtered and is diffused in the tubular part of the Nephron where the filtered excretory substrate is lying (*See Fig. 3·24*). Both mix together to form a yellow solution which is called as urine. This urine is expelled out from the kidney through a duct known as ureter. Both the ureters emerging out from both the kidneys open in urinary bladder. Urinary bladder is a muscular flexible bag-like structure which opens outside the body through an aperture known as urethra.

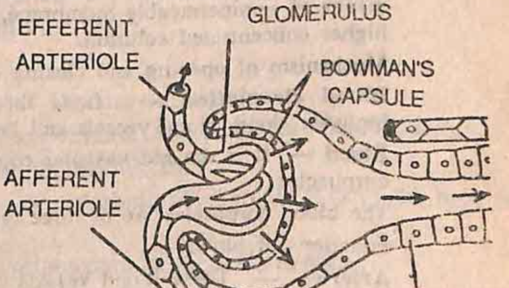


Fig. 3·24. Process of filtration beween the glomerulus of nephron and Bowman's capsule.

SUMMARY

1. **Physiology** : It is the branch of Biology which deals with some vital activities like nutrition, respiration, excretion, transportation, reproduction, growth and development.
2. **Nutrition** : It is the process to consume the food in releasing the energy for performing the vital activities.
3. **Types of Nutrition :** Autotrophic nutrition and Heterotrophic nutrition.

Autotrophic nutrition : In this type the organism is independent for its food *e.g.*, green plants.

Photosynthesis : It is the process in which the green plants are able to synthesize their food in presence of sunlight by taking CO_2 and H_2O to give rise organic compounds and free oxygen as the by-products. The whole process is completed in two parts :

1. Light reaction 2. Dark reaction

Starch is the end product of Photosynthesis. Experiments to show that (*i*) Sunlight is necessary for Photosynthesis. (*ii*) CO_2 is necessary for Photosynthesis. (*iii*) Chlorophyll is necessary for Photosynthesis. (*iv*) Water is necessary for Photosynthesis.

Heterotrophic Nutrition :

Saprophytes : Organisms which derive their food from rotten and decayed organic matter are called saprophytes *e.g.*, Bacteria, Mushrooms.

Parasites : Organisms which depend upon other livings or hosts for their food are called parasites.

Holozoic Nutrition : The organisms which feed on the solid food material are called holozoic. This type of nutrition is completed in four steps — ingestion, digestion, absorption and egestion.

Respiration — It is the vital activity in which complex food is broken down into simpler forms and energy. This whole process is completed in three steps — Inhalation, Exchange of gases and Exhalation.

Types of Respiration — Aerobic and Anaerobic. Respiration is different from breathing as well as from burning.

Transport of material :

Diffusion — It is the process of movement of molecules from the region of higher concentration to the region of lower concentration till the concentration becomes equal in both sides.

Osmosis — When two solutions of different concentrations are separated by means of semipermeable membrane, the lower concentrated solution travels towards higher concentrated solution.

Mechanism of opening and closing of stomata.

Blood circulation — It is the transport system in animals. This system includes blood, blood vessels and heart.

Blood — It is the red vascular connective tissue which is consisted of plasma and corpuscles.

The blood corpuscles are of three types — R.B.C., W.B.C. and Blood platelets.
Functions of blood —

Arteries — These blood vessels carry blood from heart to various organs.

Veins — These blood vessels carry blood from various organs to the heart.

Heart — It is the main pumping station of the blood in the animal body which is muscular, triangular, bag-like, red structure. It lies in the thoracic cavity.

Lymph — It is also the fluid connective tissue which is light yellow in colour.

Excretion — The process of expelling out the waste and harmful substances from the body is called excretion. There are four types of excretion found in human beings :

(1) Pulmonary excretion (2) Cutaneous excretion (3) Hepatic excretion (4) Renal excretion

Structure of Nephron and Mechanism of urine formation.

QUESTIONS

NUTRITION

1. Define the following :

(*i*) Nutrition (*ii*) Photosynthesis (*iii*) Digestion (*iv*) Parasite (*v*) Saprophyte

2. Distinguish between :

(*i*) Saprophyte and Parasite (*ii*) Autotroph and Heterotroph (*iii*) Egestion and Excretion (*iv*) Photosynthesis and Respiration (*v*) Herbivorous, Omnivorous and Carnivorous (*vi*) Absorption and Assimilation.

3. Write the answer either in one word or in one sentence :

(*i*) In how many major steps the Photosynthesis is completed in plants ?

(*ii*) Write the names of major steps of complete process of digestion in human being.

(*iii*) Write the names of those organs where the process of digestion occurs in the human alimentary canal.

(*iv*) Who was the discoverer of light reaction in Photosynthesis ?

(*v*) Write another name given to the process of Dark reaction in Photosynthesis.

(*vi*) What is the component of chlorophyll which is responsible to receive energy from the Sun ?

(*vii*) What is the ultimate product formed during photosynthesis ?

(*viii*) Write the names of distributers of the absorbed food material.

(*ix*) Write the name of the organelle which is responsible for photosynthesis.

(*x*) Which two factors are essential for photosynthesis ?

(*xi*) Which two raw materials are essential for photosynthesis ?

(*xii*) Which gas is evolved during photosynthesis as a byproduct ?

4. Fill in the blanks with appropriate word :

(*i*) The intermediate product of photosynthesis is............

(*ii*) .... is evolved during photosynthesis.

(*iii*) The animals depending upon dead animals are called as ....

(*iv*) The animals which depend upon other living animals are called as ....

(*v*) In symbiosis............depends upon............and vice-versa.

5. Long Questions

1. "Photosynthesis is an essential process in plants." Discuss this statement.
2. Explain with the help of an experiment that carbon dioxide is essential for photosynthesis.
3. How can you prove that sunlight is essential for photosynthesis ?
4. "Photosynthesis is not possible in the absence of chlorophyll". Explain it with the help of an experiment.
5. Which elements of food is carried by blood to various parts of the body in man ?
6. Write the names and functions of those digestive juices which are alkaline in nature.
7. Write the importance of liver in the process of digestion.

8. What is the role of Buccal Cavity in digestion ?
9. Explain in brief the starch test.
10. How can you show that oxygen is evolved from plants during photosynthesis ?

6. Diagramatic Questions

1. Draw a neat and labelled diagram of alimentary canal of man.
2. Draw a line sketch of complete process of photosynthesis.

7. True and False Statements :

Write (T) against true statement and (F) against the false statement which are given below :

(*i*) Dark reaction takes place in the night only.
(*ii*) During photosynthesis 38 A.T. P. energy is evolved in the last moment.
(*iii*) Saliva is acidic in nature.
(*iv*) Bile juice has no enzyme.
(*v*) Only the required amount of water is absorbed by large intestine in man.
(*vi*) Water is received from the atmospheric moisture during photosynthesis.

RESPIRATION

1. Define the following :

(*i*) Respiration (*ii*) Breathing (*iii*) Glycolysis (*iv*) Enaerobic respiration.

2. Differentiate between :

(*i*) Respiration and Breathing (*ii*) Anabolism and catabolism (*iii*) Aerobic and anaerobic respiration (*iv*) Respiration and combustion.

3. Write the answer either in one word or in one sentence only :

(*i*) Where does breathing occur in higher animals ?
(*ii*) What is the approximate percentage of CO_2 in exhaled air in man ?
(*iii*) What does exchange of gases occur in the human body ?
(*iv*) In what type of respiration lactic acid is formed ?
(*v*) How much quantity of energy is evolved during aerobic respiration ?

4. Fill in the blanks with suitable word :

(*i*) Respiration is a ... . while breathing is a ....
(*ii*) In aerobic respiration one gram of glucose gives rise .... K.J. and in anaerobic respiration .... K.J.
(*iii*) Respiration is............ process of metabolism.
(*iv*) Glycolysis takes place in .... of a cell.
(*v*) .... Enzymes are involved in respiration.

5. Write 'T' against the true statement and 'F' against the false statement which are given below :

(*i*) Respiration occurs in lung cells also.
(*ii*) Respiration is a slow process.
(*iii*) Breathing is completed in three steps.
(*iv*) Exchange of gases takes place in respiration.
(*v*) In respiration only carbohydrates are oxydised.

6. Long Questions :

1. Explain clearly the whole process of breathing.
2. Where does Glycolysis take place ? Explain this process clearly.

3. Explain the process of anaerobic respiration after glycolysis.
4. Explain the structure of mitochondrion in reference to aerobic respiration.

7. Diagrammatic Questions :

1. Draw the respiratory system of man and label its parts.
2. Draw the neat and well-labelled internal structutre of mitochondria.

TRANSPORT OF MATERIAL

1. Define the following :

(*i*) Diffusion (*ii*) Osmosis (*iii*) Stomata (*iv*) Blood (*v*) Artery (*vi*) Vein (*vii*) Lymph.

2. Distinguish between :

(*i*) Artery and vein (*ii*) Diffusion and osmosis (*iii*) Translocation and transpiration (*iv*) Blood and lymph.

3. Write the answer either in one word or in one sentence only :

(*i*) Who is responsible for the circulation of blood in the animals ?

(*ii*) How many chambers are there in human heart ?

(*iii*) Which part of blood carries oxygen ?

(*iv*) Which part of blood carries CO_2 ?

(*v*) Which type of tissue the blood is ?

(*vi*) Which process is helpful in respiration in lower animals and lower plants ?

(*vii*) What type of osmosis takes place if you put a grape in a concentrated sugar solution ?

4. Fill in the blanks with suitable words :

(*i*) Heart is externally covered by ....

(*ii*) The pure blood is collected in .... chamber while impure blood is collected in .... chamber.

(*iii*) Stomata are present on .... surface in Monocot leaf.

(*iv*) .... is the process through which food and other substance is supplied to various parts of the body.

(*v*) The process during which the water is expelled out from the plant body in the form of water vapours is called as ....

(*vi*) .... blood is bright red in colour while .... blood is bluish red in colour.

(*vii*) .... artery flow impure blood.

5. Write 'T' against the true statement and 'F' against the false statement :

(*i*) Stomata are the only pathway of transpiration in plants.

(*ii*) Stomata open when the guard cells expand.

(*iii*) White blood corpuscles (cells) are unicellular and amoeboid in shape.

(*iv*) Arteries are just below the skin while veins are just above the bones.

(*v*) Blood helps in maintaining the body temperature.

6. Long Questions :

1. Write the importance of blood in human body.
2. What do you mean by double circulation ? Explain it by taking example of man.
3. Explain the structure of blood.
4. Explain in brief the lymphatic system in man.
5. Write the mechanism of opening and closing of stomata.

EXCRETION

1. Define the following :

(*i*) Excretion (*ii*) Kidney

2. Distinguish between :

(*i*) Hipatic Excretion and Renal Excretion (*ii*) Urinary tube and Uriniferous tubule.

3. Write the answer either in one word or in one sentence :

(*i*) Name the excretory matter excreted by kidneys.
(*ii*) What is the excretory matter excreted by the skin ?
(*iii*) In which state the excretory matter is excreted out from lungs ?
(*iv*) Name that organ which collects the urine coming from kidneys.
(*v*) How many number of kidneys are there in man ?

4. Fill in the blanks with appropriate word :

(*i*) .... acts as the indirect excretory organ.
(*ii*) Ammonia is converted into .... and .... in liver.
(*iii*) A tuft of blood capillaries present in Nephron is called as ....
(*iv*) Right kidney is placed a bit............ than the left kidney.
(*v*) A group of .... and .... is called Malpighian Capsule.
(*vi*) The place in kidney where the arteries and veins enter and exit is called as ....
(*vii*) The structural and functional unit of kidney is ....

5. Long Questions :

(*i*) Write the importance of excretion.
(*ii*) Why the hepatic excretion is called as indirect excretion ?
(*iii*) Explain the internal structure of kidney.
(*iv*) Explain the mechanism of urine formation in human body.
(*v*) Describe the structure of Nephron.
(*vi*) Write the Excretory functions of liver in man.

6. Diagrammatic Questions :

(*i*) With the help of a diagram show the situation of kidney along with its system.
(*ii*) Draw a neat and clean diagram of kidney showing internal structure : Label its parts.
(*iii*) Draw a neat and labelled diagram of Nephron.

CHAPTER 4

LIFE PROCESSES – II

LEARNING OBJECTIVES

At the completion of this Chapter you should be able to know :–

1. Growth is a vital activity which involves five main steps :
   - (*i*) Cell division
   - (*ii*) Cell enlargement
   - (*iii*) Cell movement
   - (*iv*) Cell differentiation
   - (*v*) Cell death.
2. Two types of Growth : (1) Temporary Growth (2) Permanent Growth.
3. Reproduction is a fundamental character during which the parent living body produces new offsprings.
4. Types of Reproduction : (1) Asexual reproduction (2) Sexual reproduction.
5. Important methods of Asexual reproduction :
   - (*a*) Binary fission
   - (*b*) Budding
   - (*c*) Fragmentation
   - (*d*) Sporulation
   - (*e*) Vegetative reproduction – Leaf Propagation, Bulbils
   - (*f*) Artificial methods – Cutting, budding, layering, grafting, gootying
   - (*g*) Tissue Culture

   Sexual Reproduction – In this method male and female reproductive organs are involved. It occurs in plants as well as in animals.

   In plants – The male gamete (pollen grain) fuses with the female gamete (ovum) to give rise fruit and seeds.

   In animals – The male gamete (sperm) fuses with the ovum, the female gamete, to give rise a zygote which on development converts into an offspring.

This chapter includes – Introduction and Growth, Asexual reproduction, Sexual reproduction, Control and Coordination in animals, in plants, Nervous system.

4.1 GROWTH

INTRODUCTION :

All the living beings increase in weight and size day-by-day with the increase in their age. This type of increase may be temporary or may be permanent. On dipping a piece of cork in the liquid, it increases in size and weight but on putting it in the sunlight, comes back in its previous position, shows the *temporary growth.* A newly born baby will increase in size and weight due to the metabolic activities going on inside the body with the result of that the increased size and weight will attain permanent position in the body. Such growth is called *Permanent Growth.* Growth is one of the vital activities which can be seen in plants and animals. Though the growth occurs in plants and animals by the following of same steps even then there are some differences in the growth of animals and plants.

Growth in Plants	*Growth in Animals*
1. Growth takes place continuously.	1. Growth takes place upto a certain span of life.
2. Growth takes place in certain regions only. These regions are the tips of stem and roots and the upper and lower portions of node region and also in the steeler region.	2. Growth is uniform throughout the body but in a definite proportion.
3. Meristametic cells are present in the plants which are responsible for the growth.	3. Meristametic cells are absent in animal body.

The process of growth involves the following activities which are conducted in the living cell – (*i*) Cell division (Multiplication) (*ii*) Cell enlargement (*iii*) Cell movement ; (*iv*) Cell differentiation and (*v*) Cell death.

(i) Cell Division : For the development of the organism, cell division is essential. In the early stages of development, the cells divide mitotically to increase their number. At this stage all the cells take equal time in division. The newly formed cell contains equal number of Chromosomes like that of parent cell. Gradually cells of different parts divide at different times.

(ii) Cell Elongation : General cell division is followed by cell elongation. Just after the cell division, the cell wall of the cell becomes delicate. It receives water from the neighbouring cell which increases its turgidity with the result of that, the cell also increases in size. In such cells some material is also formed which help in Photosynthesis or food formation. These food compounds give permanent strength to the cell wall and so the cell attains the same area.

(iii) Cell Movement : When the cells are fully elongated, they start moving towards their proper position to form the organs. Their previous positions are taken up by the new cells.

(iv) Cell Differentiation and Maturation : When the cells have taken their proper position, they start doing their specific functions and can be differentiated from other cells. These cells become mature. In the whole process of differentiation and maturation, the cells remain unchanged and do all the functions.

(v) Cell Death : Differentiated and matured cell die after performing its functions. The dead cells are replaced by the new cells.

4.2 DEVELOPMENT

Development takes place in the body by the cells going through all the above mentioned stages. Many cells combine together to form a tissue. The tissues having specific functions similar structure and size form an organ.Many organs together form an organ system. Many organ systems form the total body of an organism. Thus the whole body of the individual attains a large size due to the increase in the number of cells. These changes are permanent in the body and this is called *development*. Thus the development can be defined as —

"Development is the entire process of structural transformation of an individual organism from the cell division to cell death".

REPRODUCTION :

Reproduction is a fundamental character of living organism. *It is that process under which a new offspring is produced to carry on the same species for a long time in future without any structural change in the parent body.*

There are two methods of reproduction : (*i*) Asexual and (*ii*) Sexual.

Asexual Reproduction : The word meaning of Asexual indicates that the process does not involve reproductive organs. So, there is no question of fertilization. The vegetative parts develop and attain the shape of new plant. A part breaks off from the parent plant fixes itself with some substratum in suitable condition and then starts further development.

In lower plants spores are formed which on maturation become free, float in the air and wherever they get suitable place and conditions they fix themselves and start growing. Some important methods of asexual reproduction are as below :

Binary Fission : This type of reproduction gradually occurs in Protozoan like Amoeba Eluglena (Fig 4·1) in this type, the nucleus divides amitotically into two and the cytoplasm covers each daughter Nucleus to form small daughter cells. Each daughter individual develops like its parent.

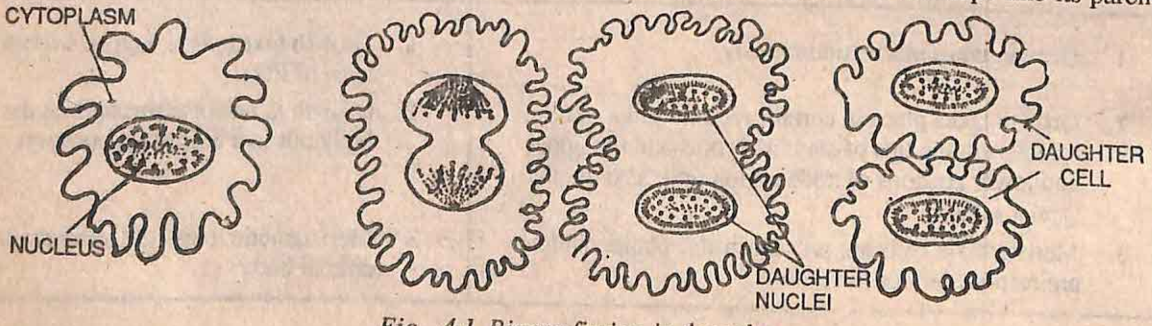
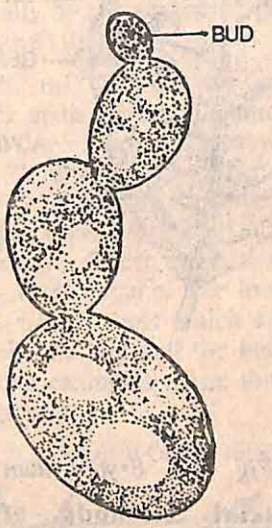


Fig. 4·1 Binary fission in Amoeba.

Budding : In this type, the cell grows a tiny outgrowth called bud (Fig 4·2). This bud develops and gets detached from the parent cell. It occurs in yeast, hydra etc.



Yeast – Reproduction by Budding
Fig. 4·2

Fragmentation : Fragmentation means pieces. In this method when any part of the plant or animal is fragmented into pieces, each piece develops to give rise a new plant *e.g.*, Spirogyra, Riccia, Hydra, Earthworm, Amoeba. (Fig. 4·3) Planeria.

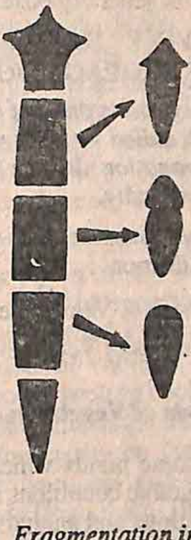


Fig. 4·3 Fragmentation in Planeria

Sporulation : It is one of the methods of asexual reproduction which takes place in seedless plants. In this method, a plant part becomes specialised having a bulbus blunt end. In side it, single celled numerous structures are produced which are called 'the spores' and the bulbus plant part is called the sporangium (*Fig 4·4*). These

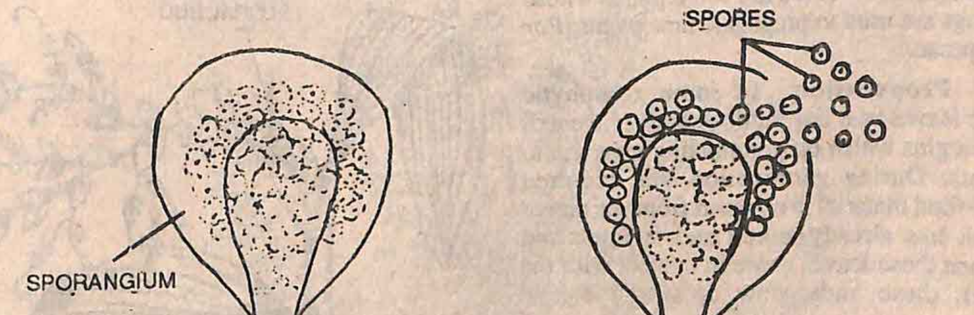


Fig. 4·4 (a) & (b) Asexual reproduction (Sporulation) in Rhizopus.

spores have a hard covering which helps them in surviving under unfavourable conditions. In favourable conditions, these spores germinate and give rise to new plants. In Fern, Moss, Mucor etc., the phenomenon is generally observed.

4.3 VEGETATIVE REPRODUCTION or VEGETATIVE PROPAGATION

When the Vegetative parts of the plant are used to propagate it is called Vegetative reproduction or Vegetative Propagation. In this method stem and leaves are used generally.

There are two main methods which are used in Vegetative reproduction :

(*i*) Natural methods of Vegetative reproduction.

(*ii*) Artificial methods of Vegetative reproduction.

Natural Methods of Vegetative Propagation :

There are some plants which live or survive only under favourable conditions and climate. Such plants are herbacious and annual. Stems, roots and leaves are used for propagation. There are three types of plants which are classified on the basis of the nature of stem, *i.e.*,

(*i*) **Underground stem plants :** Which are further divided into the following four types : (*a*) Rhizome (*b*) Corm (*c*) Bulb and (*d*) Tuber.

(*ii*) **Subaerial stem plants** which are also classified into two types :
(*a*) Runner and (*b*) Sucker

(*iii*) **Aerial stem plants** which are grown vegetatively and their stem remains in the air *e.g.*, Rose, Sugarcane, Champa, Office time flower.

Root Propagation : There are some plants whose root cuttings are used to propagate new plants. *For example* Ipecac.

Leaf Propagation *:* In some xerophytic plants, the leaves bear adventitious buds in the axil of their margins which on germinating give rise to new plants. During germination, the required amount of food material is obtained from the parent leaf which has already stored and is thick and fleshy. When these leaves come in contact with the moist soil, these buds grow up into the new plants.

Example : Bryophyllum leaves (Fig. 4·5)

Bulbils : In some plants like Oxalis Globba (Fig. 19.6) and Agava the floral buds are modified into the multicellular bodies which on coming in contact with the moist soil, propagates and gives rise to a new plant.

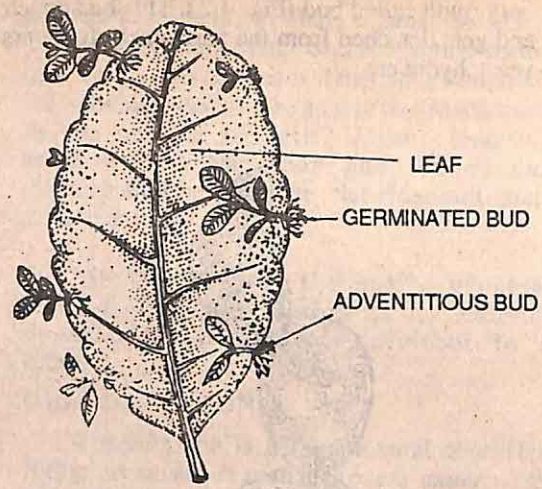


Fig. 4·5 Bryophyllum leaf

Artificial methods of vegetative propagation : No doubt Nature has provided several devices to the plants to multiply their numbers and to exist for a long time, yet man has also discovered many other methods to increase their number and yield just to fulfil his needs. These methods are named as 'Artificial methods of Vegetative Propagation'. Such methods are applied on different parts of the plant for the same purpose.

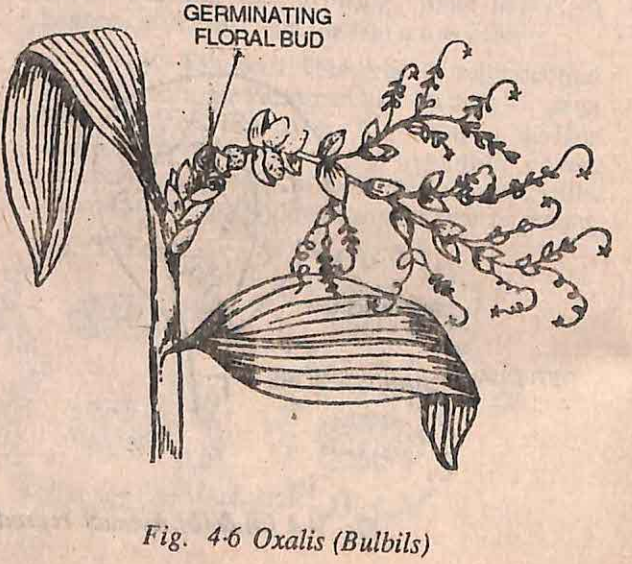


Fig. 4·6 Oxalis (Bulbils)

On the basis of the plant parts the methods applied are as follows :

Artificial Propagation : The stems of several plants are capable of giving rise to new plants and thus help in multiplying the number of the same species. The main methods which are practised generally by the gardeners, planters and horticulturists are as follows :

1. Cutting : In this method the semimature stem, branch or main stem is cut into pieces in such a way that one or two nodes may be present in each piece. These pieces are sown in the soil vertically (Fig. 4·7) keeping the lower end in the soil as in Rose, Vine, Durenta, Litchi, Guava, Citrus, Bougainvillia. These pieces may be sown horizontally as in sugarcane. The lower cut end gives off adventitious roots which establish the growing plant in the soil and the buds grow up into shoots. Other examples where this method is used are Pomegranate.

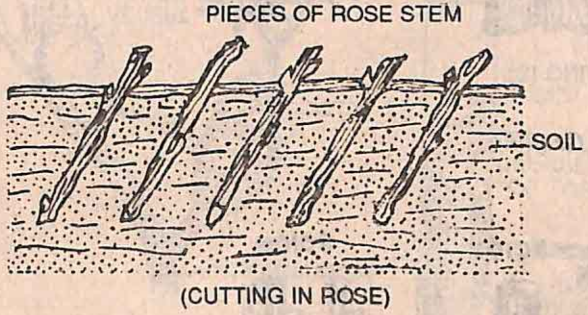


Fig. 4·7

Layering : This method is used in those plants whose branch are bent upto the soil. In this method the intact branch of the plant is bent down in the soil. The epidermis of the buried portion is removed in the girdle form and is covered with the moist soil. It is kept under heavy weight so that it may not come out from the soil. The adventitious roots come out from the girdled part within a few weeks. Then it is cut off from the parent plant and grows as an independent plant (Fig. 4·8). This method is generally used in Jasmine, Strawberry, Black berry, Motia, Lemon, Litchi etc.

Grafting : This method is generally used for growing one variety of flowers or fruits on the other variety of plant or superior variety on the inferior variety of plant. In this method we take two plants of different varieties but of the same species. Select one branch in each plant. Cut both the branches at the same angle like tongue. Fix the branch of superior variety on the other branch in such a way that the xylem and phloem tissue of both may coincide (Fig. 4·9). The former type of branch is called '*Scion*' while the later branch is called '*stock*'. The joint is wrapped or covered with a thick layer of wax or clay to protect it from the insects, bacteria and other injurious agents. After some time when the adventitious roots arise from the junction part, the scion is cut from below the union to separate it from the parent plant and the detached twig becomes part of the plant on which it has been inserted. This method is commonly used for mangoes, apples, citrus fruits, rose, peach etc.

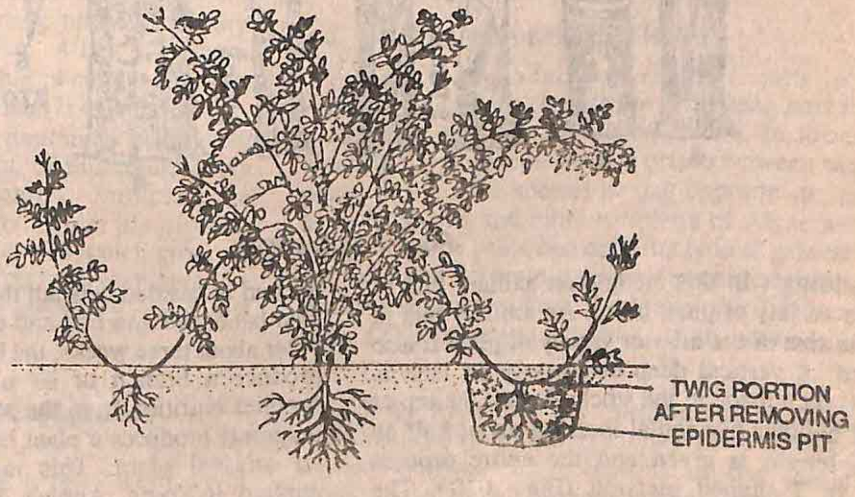


Fig. 4·8 Layering in Jasmine

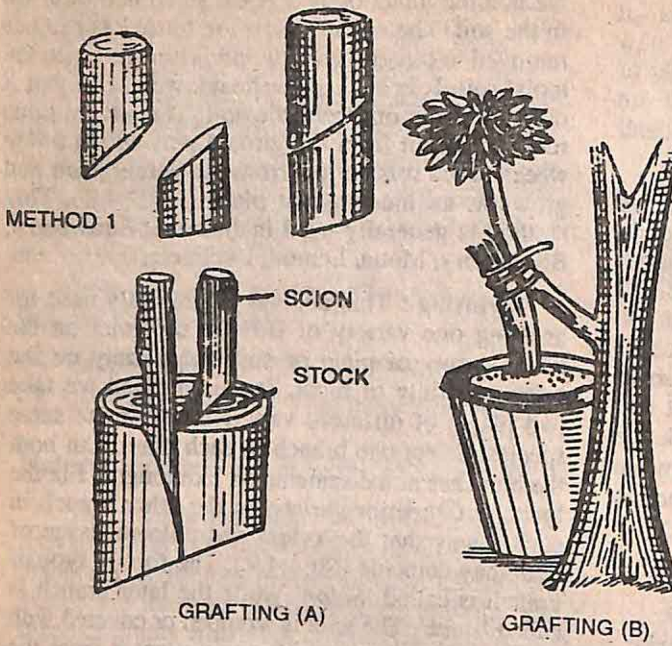
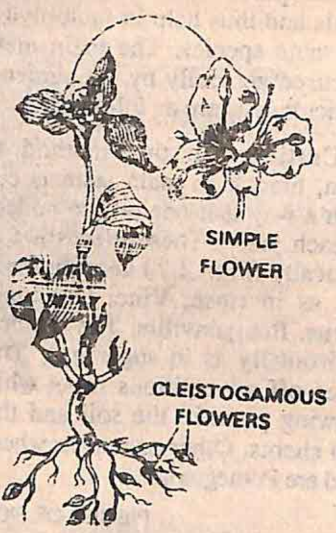


Fig. 4·9 Grafting



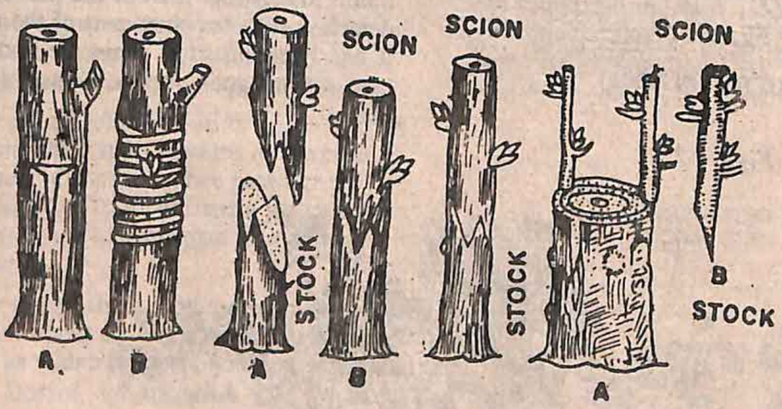


Fig. 4·10 Budding

Budding : In this method an axillary bud of superior variety of plant is cut. An axillary bud of the same size of the inferior variety of plant is also removed. A vertical deep cut, nearly an inch in length is then made in the stock. Across the top of this cut another horizontal incision about half an inch in length is given and the entire process results in T-shaped incision (Fig 4·10). The corners of the incision are lifted with a knife and the bud is inserted beneath the flaps. The wound is then bandaged and tied and the two fuse together. After about three weeks, the bud will grow out and produce a branch of its own type. The stock supplies nutrition from the soil and the bud, when it sprouts produces a plant bearing the features of its original plant. This method is commonly applied in Roses, Apples, Pears, Peach, Plum, BauganVillia, Mango etc.

Gootying : This method is used in tall trees. The terminal portion of thin branches are selected. The bark of the selected branch is removed in the form of a ring. The exposed part of the stem is covered with the soil and held in position by a piece of coconut fibre cloth and bandaged tightly outside. The soil of this piece is kept moist by applying water in several ways.The cut end gives off adventitious roots after some time and the part of the shoot just below the fibre cloth is detached from the parent plant by making notches. Then it is transplanted in the soil. (See Fig. 4·11).

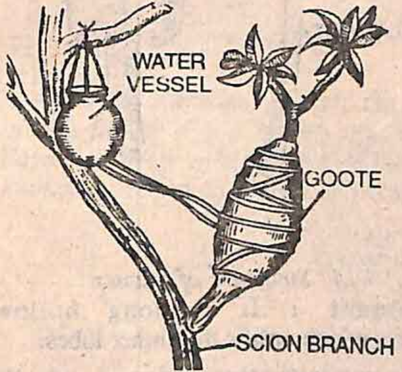


Fig. 4·11 Gootying

Tissue Culture : In this method a small piece of a tissue of a plant is cut from the plant body and is kept in a vessel containing nutrient solution under suitable conditions (Fig. 4·12). The tissue grows in size having a number of cells in the form of an unorganised manner which is called as *callus*. This mass increases continuously by further multiplication. Small portion of this tissue is put in another medium which induces the differentiation of plantlets. This plantlets is transplanted into other pots or soil which grows to maturity. Asparagus, Orchids, Chrysanthemums and many other plants are grown by using this method.

Importance of Vegetative Propagation :

1. It is a simple process and it takes less time to grow the plant.
2. The wild and less useful plants are also used in this method.
3. Various varieties of a species can be grown on a plant by this method.
4. Seedless fruits can be grown by this method.
5. The crop is protected from diseases and germs by this method.
6. The thorns and spines can be lessened in number with this method.
7. A number of good varieties of different types of fruits can be grown with this method.
8. The producer has full confidence over the variety of the fruit grown with this method.

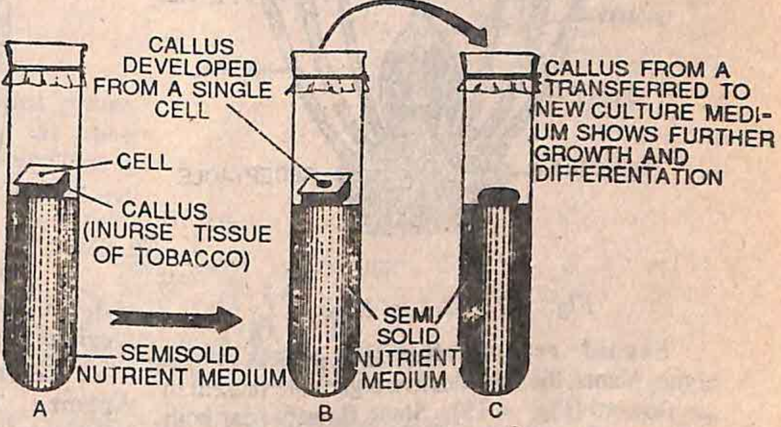

CALLUS DEVELOPED FROM A SINGLE CELL
CELL
CALLUS (INURSE TISSUE OF TOBACCO)
SEMISOLID NUTRIENT MEDIUM
SEMI SOLID NUTRIENT MEDIUM
CALLUS FROM A TRANSFERRED TO NEW CULTURE MEDIUM SHOWS FURTHER GROWTH AND DIFFERENTATION
A
B
C

Fig. 4·12 Tissue culture

4.4 SEXUAL REPRODUCTION :

Sexual reproduction is that type of reproduction in which both the sexes take part in producing new and similar off spring. In lower plants this type of reproduction occurs between two plants of the same species having opposite strains as in spirogyra and other members of Algae and Fungi. In some cases two opposite type of gametes are produced separately which fuse together *i.e.*, fertilization takes place. After that the fertilized body (Zygote) starts growing as an individual plant.

Male gametes are produced in male reproductive organs present in male body while the female gametes are produced in the female reproductive organs present in the female body. Such organisms are called the unisexual organisms. The organism, which possesses male and female reproductive organs both, are called *bisexual* or *hermaphrodite*.

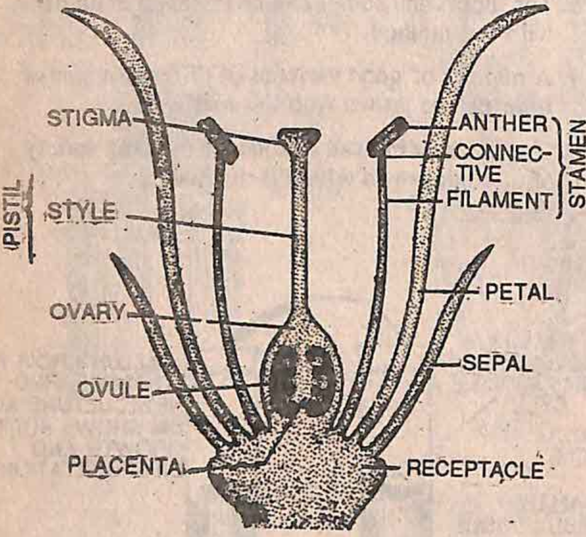


Fig. 4·13 L.S. of Flower

Sexual reproduction in plants : In higher plants, the reproductive organs are present in the flowers (Fig. 4·13). Some flowers bear both male and female reproductive organs are called *bisexual or hermaphrodite flowers.* While some flowers bear only one type of reproductive organs are called *unisexual flowers.* The flower bearing male reproductive organs is called male flower and the flower bearing female reproductive organs is called Female flower. The plant bearing male and female flowers both is called *monoecious plant* and when the plant bears only one type of flowers is called *dioecious plant.*

Male reproductive organs of the plant are called as *stamens.* The whorl of stamen is called *Androecium.* Each stamen is mainly composed of three parts (See Fig. 4·14).

(a) Anther : It is the uppermost exposed part and is generally divided into two anther lobes. Each anther lobe is internally divided into two Pollen chambers or Pollen sacs. Both the anther lobes are inter connected at the centre having the Vascular bundle and is called as connective. Each Pallen sac bears several Pollen mother cells which on multiplying meiotically, give rise to numerous haploid Pollen grains.

(b) The Connective : It is the smallest and delicate part which makes connection of anther lobes with filament.

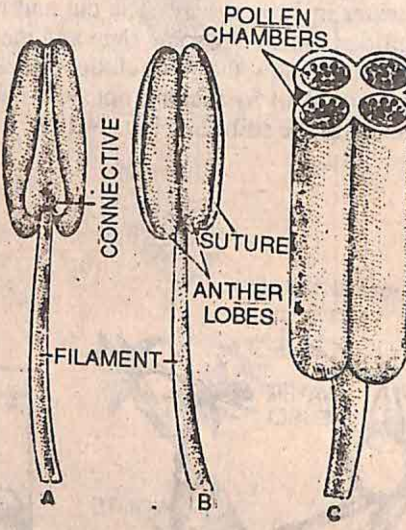


Fig. 4·14 Structure of Stamen

(c) Filament : It is long hollow, cylindrical tube which uplifts the anther lobes.

Female reproductive organs of the plant : The female reproductive organ of the plant is called Gynoecium or pistil which is generally situated in the centre of the flower (See Fig 4·15). It is also composed of three main parts –

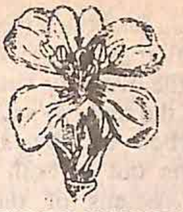
(a) Stigma – It is the broad but flat part lying at the top of the pistil and receives the pollen grains.

(b) Style : It is long, cylindrical and hollow tube which connects the stigma with ovary and also provides passage for travelling the pollen tube.

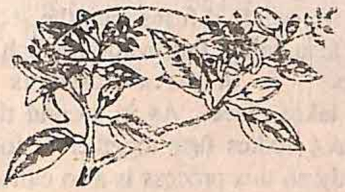
(c) Ovary : It is most important part of the pistil which forms the base of the pistil. It is broad and bears the ovules.

Pollination : The *transference of Pollen grains from the stamens upto the stigma of the flower is called Pollination.The transference is carried out by wind, water, insect, birds or man (Fig 4·15).*

Pollination is of two types—(*a*) Self pollination (*b*) Cross pollination.



SELF POLLINATION



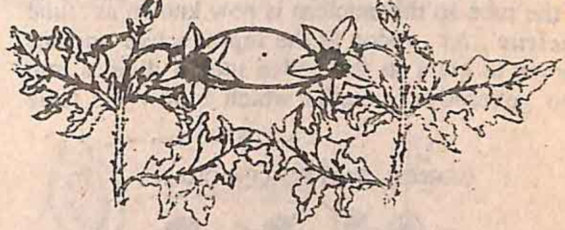
SELF POLLINATION

Fig. 4·15

Self Pollination : *When the pollen grains of one flower reach to the stigma of the same flower or of the other flower of the same plant is known as self pollination.* Generally it does not require any agent but in some cases air acts as the agen(See Fig. 4·15).

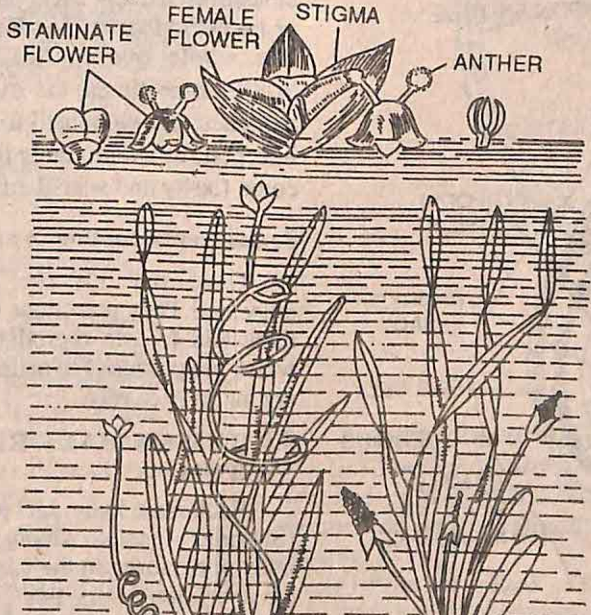
Cross Pollination : *In this type of pollination, the pollen grains of one flower transfer to the stigma of the other flower of the other plant.* Generally it requires some agents to carry them. There are the following main agents for cross pollination – Air, Water, Insects and Animals. (See Fig. 4·16)

CROSS POLLINATION



Wind Pollination

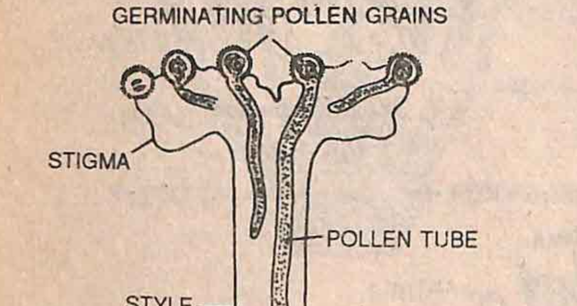
Fig. 4·16



WATER POLLINATION VALLISNEREA (A HYDROPHYTIC PLANT)

Fig. 4·16

Fertilization : On maturation of the pistil the inner cells of style dissolve and convert into a viscus and special scented liquid some amount of which comes out on the stigma which helps in sticking the pollen grains while some amount goes down to make the path smooth and slippery. See Fig 4·17. Thus a vacuum is created in the style region. The pollen grain present on the stigma, is influenced by this vacuum, due to which, the intine of the pollen grain comes out in the form of a blind tube known as *pollen tube*. The cytoplasm and vegetative nucleus comes first in the tube so this nucleus is now known as '*tube nucleus*'. As soon as the reproductive nucleus comes to enter in the pollen tube it divides into two generative nuclei which follow the tube nucleus. On reaching the pollen tube near the ovule it enters into the micropyle. As soon as it touches the embryo sac of the ovule the anterior wall of the tube as well as of the embryo sac burst, the tube nucleus is absorbed by the synergids. One generative nucleus out of both fuses with the egg cell. The nucleus of the generative nucleus fuses with the nucleus of egg cell. This process is known as *fertilization*. The remaining other generative nucleus enters the middle of embroyo sac where it fuses with the secondary nuclei. It is also called fertilization which occurs second time, so in the angiosperms *double fertilization* takes place. As in second time the nuclei of three bodies fuse together to form one common body so this process is also called triple fusion.



V.S. of Gynoeceum of Angiospermic flower

Fig. 4·17

After fertilization, the petals, sepals, stamens, style and stigma of the flower fall off. Now the ovary is converted into fruit, while the ovule is converted into seeds.

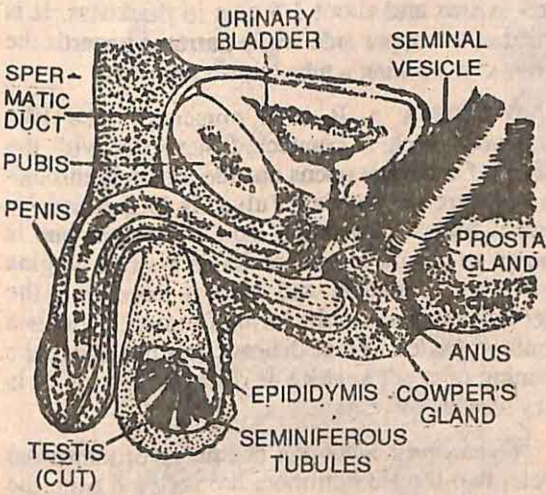
Seed is the modified form of the plant in which plant lies inside it in dormant conditions. Each seed has two seed coats, one or two Cotyledons, one Radicle and one Plumule. The whole ovary after fertilization is called '*fruit*'. Some times, the ovary walls may become hardened and elongated to convert the whole fruit into pod. In some plants the ovary walls may become fleshy and succulent *e.g.*, tomato, plum etc.,

Sexual reproduction in animals

Generally all the higher animals are unisexual.They reproduce sexually. In this process male and female reproductive gametes take part which are produced in male and female reproductive organs respectively.

4.5 HUMAN MALE REPRODUCTIVE SYSTEM :

Each male individual possesses a pair of Testes (Singular – testis) which are situated outside the body posteriorly on the ventral surface of coelomic cavity. Each testis lies in a muscular bag like structure which is called scrotal sac or scrotum (Fig. 4·18). Each testis is oval in shape and is connected with the basal inner part of the scrotum through a bundle of muscular threads which are called as Gubernaculum. It is covered externally by a layer of connective tissue called Tunica albuginea. Towards inner side it is divided into many parts which are known as lobules. Each lobule consists of one to four coiled tubule named as *seminiferous tubules* (Fig. 4·18). Each seminiferous tubule is lined by a single layer of cells which are called as spermatogonia. This layer is called as germinal epithelium. Some special type of long cells are present at various places in the germinal epithelium which are named as *Sertoli cells*. These cells act as the nutritive cells for the developing sperms while the spermatogonia cells divide to give rise to haploid sperms through *spermato genesis* (process of formation of sperm).



Mala human reprodustive system
Fig. 4·18

Seminiferous tubules are supported by connective tissues in which some special cells are found in the scattered form which are called as Interstitial cells or Leydig cells. These cells produce the male hormone which is named as Testosterone. It exercises to control over the secondary sexual characters of man.

STRUCTURE OF SPERM :

Each sperm (Fig 4·19) consists of three parts : (*a*) Head, (*b*) Middle piece and (*c*) Tail. The *head* is the broad anterior most part which is spherical in shape having a nucleus in the centre.There are only 23 chromosomes in the nucleus.

The *middle piece* lies below the head and contains mitochondria and centriole.

Tail is the hindmost long and tapering cytoplasmic part which is devoid of nucleus. It helps the sperm in swimming in the fluid.

Other parts of the male reproductive system are –

(*i*) Epididymis which is long corded tube attached exteriorly with each testis.

(*ii*) *Vas deferens :* It is a long tube attached with the epididymis at one end with the duct of seminal vesicle on the other end.

(*iii*) *Urethra :* It is muscular tube of 7 to 9 inches long. It is connected with the urinary bladder with the penis and also with seminal vesicle and prostate gland.

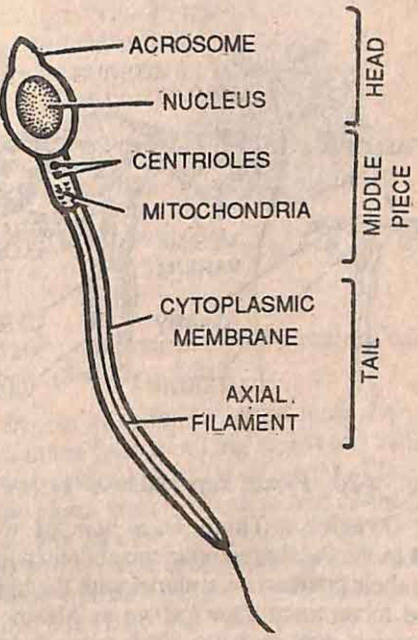


Fig. 4·19 Human Sperm

(*iv*) *Seminal Vesicle : :*It is one pair situated near the urinary bladder. These glands secret a viscus fluid which makes the essential component of semen.

(*v*) *Prostate gland* : There is also a pair of prostate gland situated near the neck of the urinary bladder and seminal vesicles. They secret an alkaline secretion which makes the semen alkaline. Sperms are motile only in alkaline medium. It gives a characteristic odour to the semen.

(*vi*) *Cowper's gland* : This gland is also situated at the base of penis. It secrets a colourless clear viscus fluid which helps as the lubricant during function.

(*vii*) *Penis :* It is highly muscular tube like structure which is having a network of blood capillaries blood space and nerves. It is situated outside the body in between both the testes. It becomes straight and turgid when the blood spaces are filled with the blood. The tip of penis is covered with a sensitive fold of skin known as glans penis. Penis helps in copulation and in the transference of semen in the female reproductive tract.

4.6 FEMALE REPRODUCTIVE SYSTEM:

The female reproductive organs are present in the lower part of the abdominal cavity. This system includes – A pair of ovaries, A pair of fallopian tubes, single uterus and one vagina (Fig 4·20).

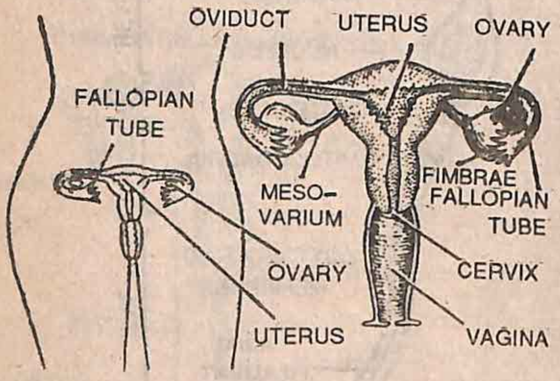


Fig. 4·20 Femal Reproductive system

(i) Ovaries : There is a pair of ovaries situated in the Pelvic region in the abdomen and are fixed at their position near uterus with the help of a thin and loose membrane known as Mesovarium. Each ovary is oval in shape. Each ovary consists of connective tissues and some groups of cells which is called as *follicle*. Its outermost covering is a single celled thick, is known as germinal epithelium (*Fig 4·20*). Numerous cells are present inside the germinal epithelium in the form of a group. One ovum is surrounded by the cells of mass. There are several follicles in an ovary. Only one ovum matures in one follicle of one ovary. About fourteen days after of the start of menstrual cycle, one ovum starts maturation in one follicle and comes to lie near the surface and projects out. The process of maturation of ovum starts just after crossing the puberty age. During this period, the follicle stimulating hormones begins to form in the anterior to be of pituitary gland. This hormone affects over the process of multiplication of cells formation and maturation of ovum.

FALLOPIAN TUBE : There is a pair of fallopian tubes which are hollow, muscular and double-walled. Each of them lies on either lateral side of uterus which are internally connected to it. Each fallopian tube is thick near the uterus while tapers upto the free end which comes near the uterus. This end opening is surrounded by several finger like folds which are known as Fimbrae. The inner layer of epithelium possesses the ciliated cells. These cells help in catching the released ovum from the abdomen.

UTERUS : It is a pear-shaped body which is situated between the urinary bladder and the rectum. It is hollow double-walled and a muscular organ. The inner surface is lined by a thin membrane known as Endometrium. It is about 7·5 cms × 5 cms in size and about 3·5 cms in thickness. It is broad at the upper side while narrows towards the lower side forming a tube known as *cervix*.

VAGINA : It is a muscular tube like structure which is connected interiorly with the cervix of uterus. It opens outside the body through an aperture known as Vulva. It is guarded by double folds of muscular skin. The outer one is known as Pelvic majora or Lavia majora. Vagina helps in copulation and also in receiving the sperms from male in the form of semen. There is a small protruded fold of delicate skin just above the opening of urethra which is called as clitoris. It is very sensitive in nature.

Ovulation : Since the beginning of menstrual cycle, two female hormones are secreted from the interstitial cells of ovary which are named as *Oestrogen* and Progestron. The Progestron controls the development of fertilized egg while the oestrogen affects the secondary sexual characters.

Copulation : The process of mating of male and female is known as copulation. In this process the sperms in the form of semen is poured in the uterus of female. Now the sperms start moving into the fallopian tubes. At the same time the ovum travels in the fallopian tube towards the uterus.

FERTILIZATION : When the nucleus of sperm fuses with the nucleus of ovum, this process is known as Fertilization and the fused body is called as Zygote. The life span of a sperm is 48 hours and that of ovum is 24 hours. So the pregnancy occurs only when fertilization occurs within the life period. The fertilized ovum or zygote frequently moves towards the uterus where it attaches with the endometrium or inner wall of

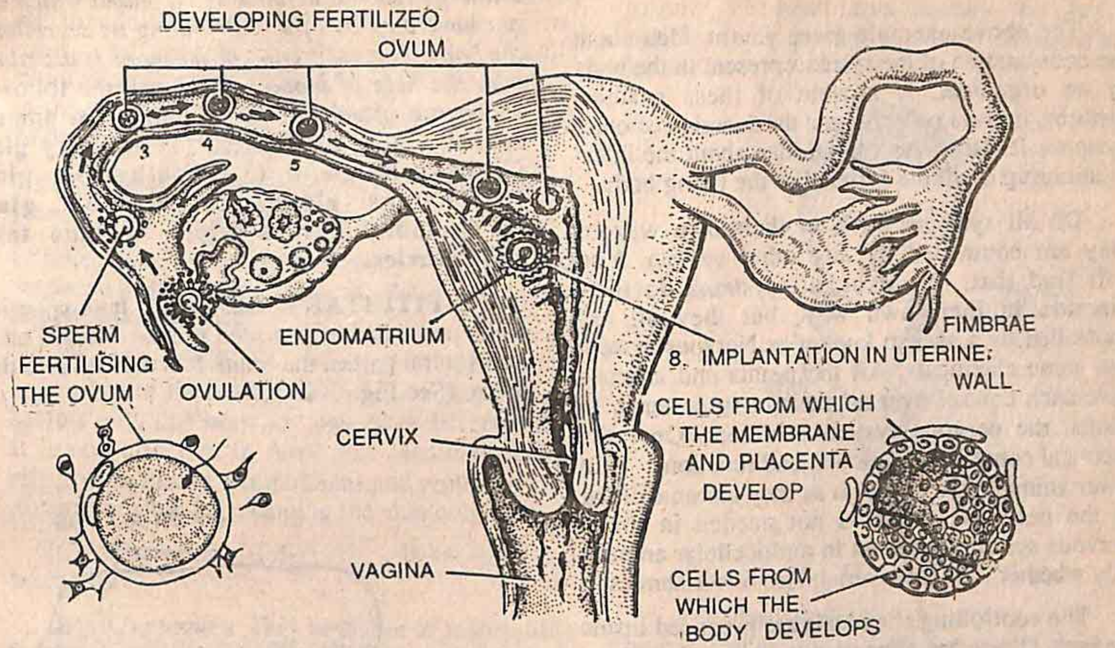

DEVELOPING FERTILIZEO OVUM
3
4
5
SPERM FERTILISING THE OVUM
ENDOMATRIUM
OVULATION
FIMBRAE
8. IMPLANTATION IN UTERINE WALL
CELLS FROM WHICH THE MEMBRANE AND PLACENTA DEVELOP
CERVIX
VAGINA
CELLS FROM WHICH THE BODY DEVELOPS

Fig. 4·21

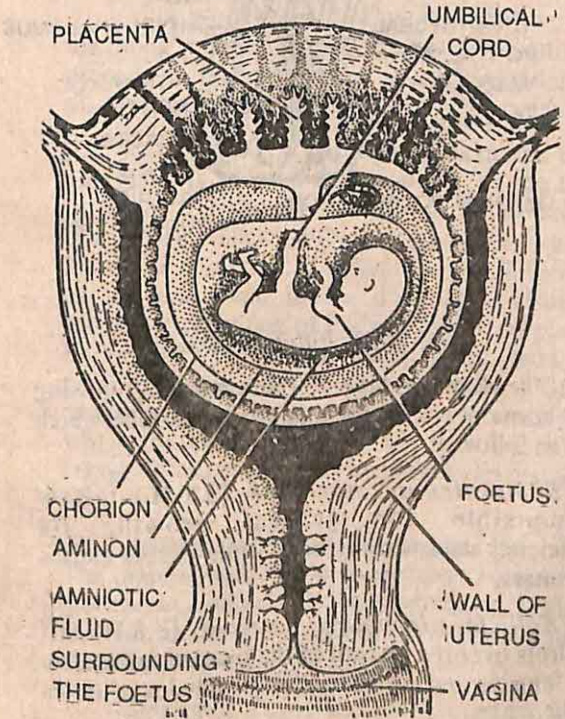


Fig. 4·22

uterus and starts development. This process is called *implantation* (See Fig. 4·21).

The Zygote after implantation makes a vital connection in the form of a long coiled and twisted chord like structure known as *placenta* Placenta contains the blood vessels which makes connection between mother and the embryo (See Fig. 4·22) After pregnancy the menstruation and evolution stop. A male human being can produce sperms throughout his life but the female human being liberates egg or ovum upto 45 years to 50 years of age. After this age menstruation stops. The stage is called as Menopause stage.

It is possible to control the population. There are several mechanical, chemical and surgical devices available which can prevent the union of sperm with ovum.

Control and Coordination

If you run fast, your legs will move swiftly. The rate of your breath will increase and after some time your muscles of legs and thorax will decrease their function. The rapid breathing will provide you more oxygen which will help to catalise your food in your body and that will provide you more energy for your extra work of running. Your muscles also help you in running but upto certain extent then afterwards their action will slow and you will feel tiredness.

The above example gives you an idea about the coordination of the systems present in the body of an organism. If anyone of these systems disturbs, it gives reflection on the function of other systems. It also gives you an idea about the interrelationship of all the systems of the living body.

Do all systems work in their own way or they are controlled by any other system. You will find that, no doubt, all systems do their function in their own way, but they all are controlled by a system known as Nervous system and some chemicals. All the plants and animals have such control over all their body systems. In plants, the nervous system is absent. Only the chemical control, their growth and functions. In lower animals like protozoa as they are unicellular so the nervous system is not needed in them. Nervous system is present in multicellular animals only whether they are invertebrates or vertebrates.

The controlling chemicals are produced inside the body. There are some glands which secret these chemicals are known as hormonic glands or *Endocrine glands* (Fig. 4·23). The secretion secreted out from these glands is called hormone and so these glands are also called as hormonic glands. *These glands are defined as the gland which does not have any duct for distributing its secretion in the body. Their secretion or hormone is distributed with the help of blood.* There are the following endocrine gland found commonly in animals, specially in human beings : (1) **Pituitary gland** (2) **Thyroid gland** (3) **Parathyroid gland** (4) **Thymus gland** (5) **Adrenal gland** (6) **Gonadial glands which include testes and ovaries.**

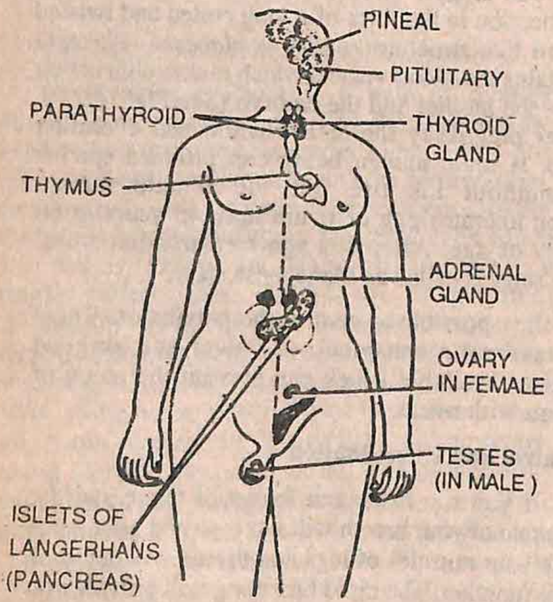


Fig. 4·23

1. PITUITARY GLAND : It is spherical, white and equal to pea seed in size situated on the mid ventral part of the brain. It is divided into three lobes (See Fig. 4·24).

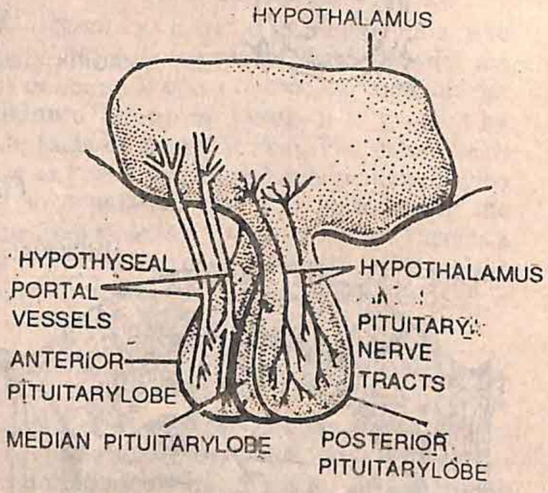


Fig. 4·24 Pituitary gland

(A) *The Anterior lobe :* There are the following six hormones secreted out from this lobe which are as follows :

(*i*) *Somatotropi hormone* (S.T.H.) : It is responsible for general growth. Its deficiency causes dwarfness while excess causes giantness.

(*ii*) *Follicle stimulating hormone* (F.S.H) : It controls over the growth of the ovarian follicles in the females and the seminiferous tubules of testes in the males.

(*iii*) *Lectogenic hormone* (L.T.H) : It controls the production of progestrone in corpus liteum and prolactin during delivery period which induce the milk glands to produce milk.

(*iv*) *Leutinizing hormone* (L.H) : It is responsible for the development of corpus luteum in the ovaries of females. In males interstitial cells stimulating hormones (I.C.S.H) is produced which initiates the interstitial cells for producing Androgen, the male hormone.

(*v*) *Thyrotropic hormone* (T.S.H.) : It initiates the growth and activity of thyroid gland.

(*vi*) *Adrenocorticotropic hormone* (A.C.T.H) : It is responsible for producing hormone in the cortex region of adrenal gland.

(*B*) **Intermediate lobe** : This lobe is situated in the middle of Pituitary gland which secrets only one hormone named as **Intermedin.** It is non-effective in Aves and Mammals but is effective in Pisces, Amphibians and reptiles where it is responsible for changing the skin colour.

(*C*) **Posterior lobe** : It secretes two hormones :

(*i*) **Oxytocin** : This hormone is responsible for the activity of muscles of urinary bladder and uterus and also milk producing activity in the mammary glands.

(*ii*) **Vasopressin** : This hormone controls the blood pressure in arteries and also contracting process of the muscles of urinary bladder, gall bladder and unstripped muscles of other organs.

2. Thyroid Gland : In human beings this gland is situated on either side of the larynx in the neck region. It is one but is divided into two lobes. These lobes produce a hormone known as *thyroxine*. It contains about 65% Iodine of the body and amino acid. It controls the metabolic activities of body cells. So, it plays an important role in the activity and growth of nervous system and skeletal system. Its deficiency causes a disease in children named as *cretinism* in which the main symptoms are slow heart beats, lazyness, weakness in brain and dwarfness in the body.

In adults, this disease is named as *Myxoedema*. The main symptoms are – increase body weight, general weakness, skin becomes thick, falling of hair on head, less activeness of body muscles, decrease of reproductive activity.

Sometimes this gland swells up due to the lack of Iodine and becomes more active. This results the gland being projected out in the neck. This disease is called *simple goitre* (Fig 4·25). It causes unnecessary excitation in the body due to the increase in the rate of metabolic activity. The heart beats increase, the eyes buldge out. He feels general weakness, restlessness and irritation.

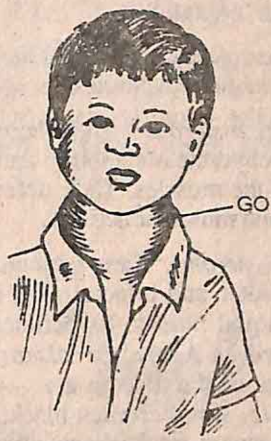


Fig. 4·25 Simple Goitre Patient

3. Parathyroid Gland : In human beings it is present in the neck region. It is divided into four lobes, two lobes on either side of larynx or sound box in the dorsal side. There are two hormones produced in these lobes – the *Parathormone* and *Calcitonin*. These harmones control the quantity of calcium and phosphorus in the blood when the calcium decreases in the blood, Parathormone is produced due to the presence of which the calcium of bones begins to move towards blood. On increase of the calcium particles in the blood calcitonin hormone is produced which changes the flow of calcium particles from blood to bones. Thus these hormones affect the growth of bones and teeth. In the deficiency of these hormones in the blood, the person experiences twiching of the nerves and muscles, fatigue, weakness in body and brain. This disease is known as *Tetany*. In the excess of these hormones, the person loses his appetite, starts vomitting, degeneration of bones and anuria occurs (stoppage of the formation of urine).

4. Thymus Gland : This gland is situated near the heart in the thoracic region. It is bilobed and light purple in colour. It is enlarged in size in childhood but gradually decreases in size with the increase of age and disappears after puberty. Its function is not yet known but according to some scientists the main function of its hormone is to check the growth of sex organs in childhood.

5. Adrenal Gland : There is a pair of this gland situated on the outer ventral surface of each kidney in frog but in man they are situated near each kidney. This gland is also named as *supra renalglands*. Each gland consists of two parts – the outer part is known as *Cortex* while the inner part is called as the '*Medulla*'.

The cortex produces about 30 hormones which are divided into three categories.

(*a*) *Cortico-sterone* : These hormones control over the carbohydrate Metabolism and maintain the capability of the muscles. Their deficiency effects the appetite and muscular activity.

(*b*) *Aldo-sterone* : These hormones control the quantity of water and mineral salts in the blood, lymph and liquid tissues. Its deficiency causes a disease named as *Addison's disease*. The main characteristics of the disease are — decrease of blood pressure, skin becomes black, the muscles and nerves become weak, digestion also becomes weak.

(*c*) *Andogens* : This group contains those hormones which have the properties similar to reproductive hormones.

Medulla : Adrenaline hormone is produced in this region. It exerts control over the sympathetic nervous system and unstriated muscles. It is generally secreted during fear, anger, fight and other sentimental occasions. This increases the energy production, pupils of eyes dialate and the skin hair become straight or erect.

6. Islets of Langerhans (Pancreas) : These are the groups of some special cells found in Pancreas in the scattered form. A hormone is formed in these cells which is called as *Insulin*. It controls the metabolic activities of fats and carbohydrates. Its deficiency checks the conversion of sugar into glycogen and entry of glucose in the tissues. Thus sugar contents of the blood increases and ultimately passes out from the body through urine. This disease is known as **Diabetes.**

7. Gonadial Glands : The male and female reproductive organs also produce hormones. So they are also studied under this head.

Testes : There is a pair of testes in man situated outside the body in the scrotal sacs. Each testis consists of numerous seminiferous tubules. There are some special cells found in small groups among the seminiferous tubules which are named as interstitial cells. They secret two hormones named as *Testosterone* and *andosterone*. These hormones are responsible for the development of beard and mustaches, heavy voice, proper development of sex organs and sexual desire. In their deficiency, the man lacks the proper development of sex organs. Such person is called as *Eunuch*.

OVARIES : There is a pair of ovaries in the female which are situated inside the abdomen. In each ovary eggs are produced in the follicular epithelium. When the egg comes out from it, it is filled with a group of cells which are yellow in colour. These cells are called as the Corpus luteum. Progesterone hormone is produced in these cells. Another hormone named as *Oestradiol* is also formed which is responsible for the development of mammary glands and exerts control on menstrual cycle etc.

Progesterone is responsible for the formation of uterus, egg and the development of embryo, placenta formation and the development of teats on the mammary glands and pubic hair.

4.7 CHEMICAL CO ORDINATION IN PLANTS

In plant body, the cells produce certain chemicals of special type which within the cells regulate and control the growth of the whole plant body. All the chemicals are not growth promoting. Some are anti-growth and other activities while some are growth promoting. So these chemicals are referred as *growth regulators* in plants. They are also called as Auxins, Cytokinin etc. Their physiological effects on the plant body are as follows :

AUXINS : It is a group of plant hormones produces in the cells of root tips and stem tips. They promote the growth of the shoot. They are responsible for bending the aerial parts of the plant body towards sunlight. They increase the length from the terminal buds but inhibits the growth in the lateral buds. Auxins also oppose the growth of the decapitated root. Auxins also promote the elongation of the cells during growth. They initiate the development of roots. They are responsible for the development and ripening of the fruits without fertilization. They also cause falling of leaves and growth and blooming of flowers. A very little amount of these plant hormones are sufficient for all these activities.

CYTOKININS : These chemicals are generally produced in the endospermic part of the seeds and the roots of the plants. Their importance in the plant body is due to the promotion of the following activities :

- (*i*) They promote the mitotic cell division in the plants.
- (*ii*) They are responsible for the enlargement of the cells.
- (*iii*) Differentiation of shoot buds is due to cytokinin.
- (*iv*) They also promote the growing and blooming of flowers in certain short day plants.

GIBBERELLINS : These chemicals are the regulators in the plant body, which are produced in the growing tips. Their effect on the activities of the plant body which are follows :

- (*i*) They stimulate the mitotic and meiotic cell division in the plant body.
- (*ii*) Cell elongation and enlargement is also affected by them.
- (*iii*) They induce the germination in the dormant seeds.
- (*iv*) They also induce flowering in long day plants under short day conditions.
- (*v*) They discart the metabolic activities of food in the seeds during preserving conditions.

ABSCISIC ACID : It is thought to be regulator :

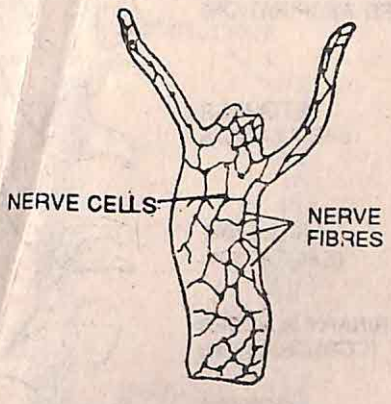
- (*i*) It increases the dormancy and budding period in seeds.
- (*ii*) It induces falling of leaves, flowers and fruits from the trees.
- (*iii*) It discarts the effect of auxins and gibberellins in the plants.
- (*iv*) It retards the growth of the plant.

4.8 NERVOUS SYSTEM :

Some animals are unicellular while others are multicellular. In the multicellular animals body many similar cells constitute tissues which form organs. These organs form the organ-systems and the later ones constitute the whole body of an organism. But can you explain that how does the co-ordination between various systems take place ? You know that all the environmental factors affect the whole body which respond by different organs. But think that how does the animal get response to the environment ? This whole function of receiving the stimuli and giving the response by the body organs is conducted by a system known as *Nervous system*. The endocrine system controls over the function and development of the body organs but does not correlate the actions and coordinate the organs to each other. So the nervous system performs such functions and has its own importance in the body.

NERVOUS SYSTEM IN HYDRA :

The body of Hydra is simple diploblastic but multicellular. A large number of nerve cells are present on the ectodermal layer which form a special type of network over whole body (Fig. 4·26).

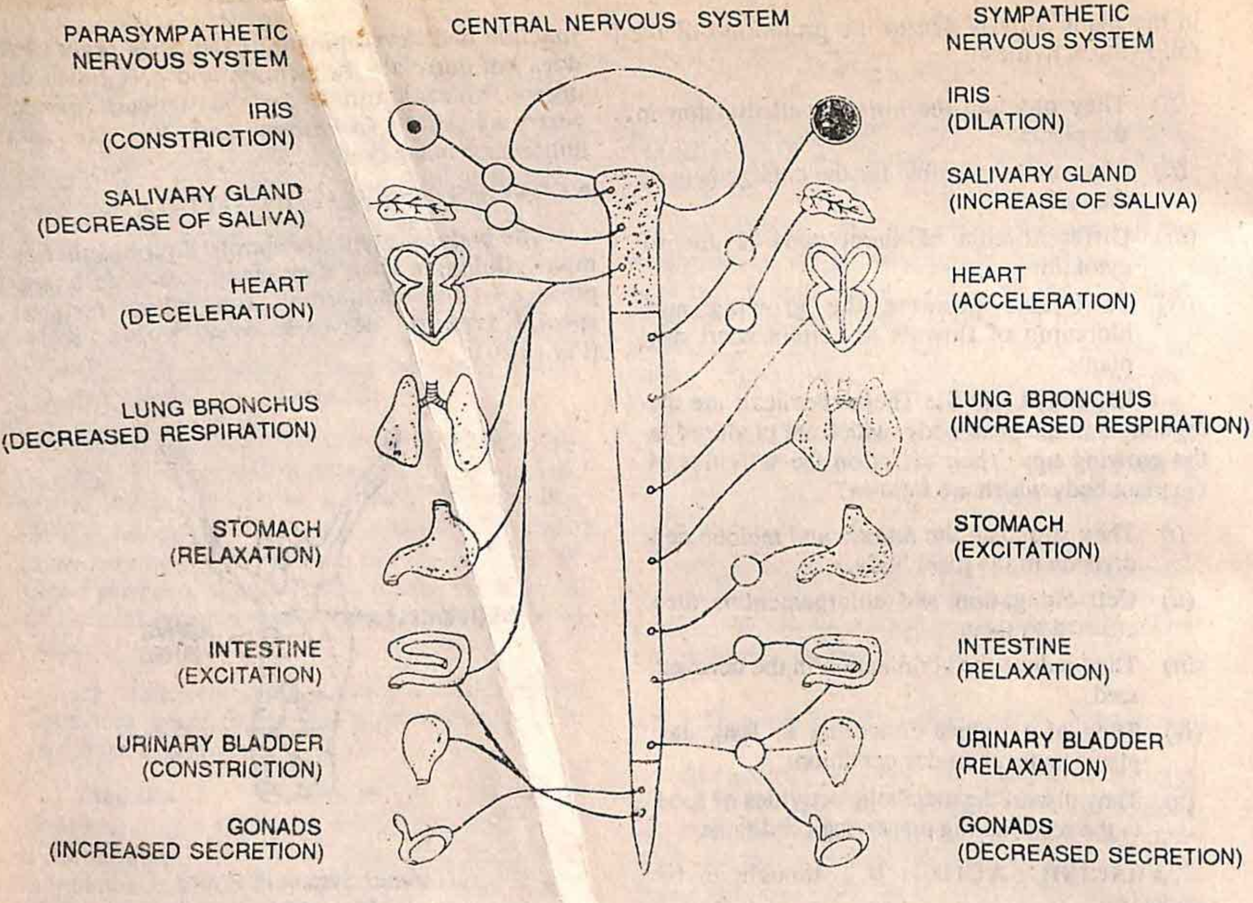


Nervous System in Hydra
Fig. 4·26

Each nerve cell is a small cell having bipolar and multipolar shape. It has a big nucleus in the broad portion while the fine processes are in all the sides. These cells help in transmission of the impulses. In addition to nerve cells, sensory cells are also present which perform the function of sensation. Each sensory cell has a cup-shaped structure at its free end having a sensory cilium in the centre. Many fine processes arise from the base of the cell which form a connection with the network of nerve cells. These cells receive many types of stimuli like touch, temperature, light, chemical etc. These sensory cells act as the sensory organs in Hydra.

Nervous system in human beings

The human body is very complicated. The coordination of the organs and the controlling of their functions is essential. For successful living, sometic response and electro-chemical responses are essential. Nervous system do also such functions. The whole nervous system is divided into three main parts (See Fig. 4·27).


PARASYMPATHETIC NERVOUS SYSTEM
CENTRAL NERVOUS SYSTEM
SYMPATHETIC NERVOUS SYSTEM
IRIS (CONSTRICTION)
SALIVARY GLAND (DECREASE OF SALIVA)
HEART (DECELERATION)
LUNG BRONCHUS (DECREASED RESPIRATION)
STOMACH (RELAXATION)
INTESTINE (EXCITATION)
URINARY BLADDER (CONSTRICTION)
GONADS (INCREASED SECRETION)
IRIS (DILATION)
SALIVARY GLAND (INCREASE OF SALIVA)
HEART (ACCELERATION)
LUNG BRONCHUS (INCREASED RESPIRATION)
STOMACH (EXCITATION)
INTESTINE (RELAXATION)
URINARY BLADDER (RELAXATION)
GONADS (DECREASED SECRETION)

(Nervous System of Man)
Fig. 4·27

1. *Central Nervous System :* It includes the brain and the spinal cord.

2. *Peripheral Nervous System :* It includes the cranial nerves and the spinal nerves.

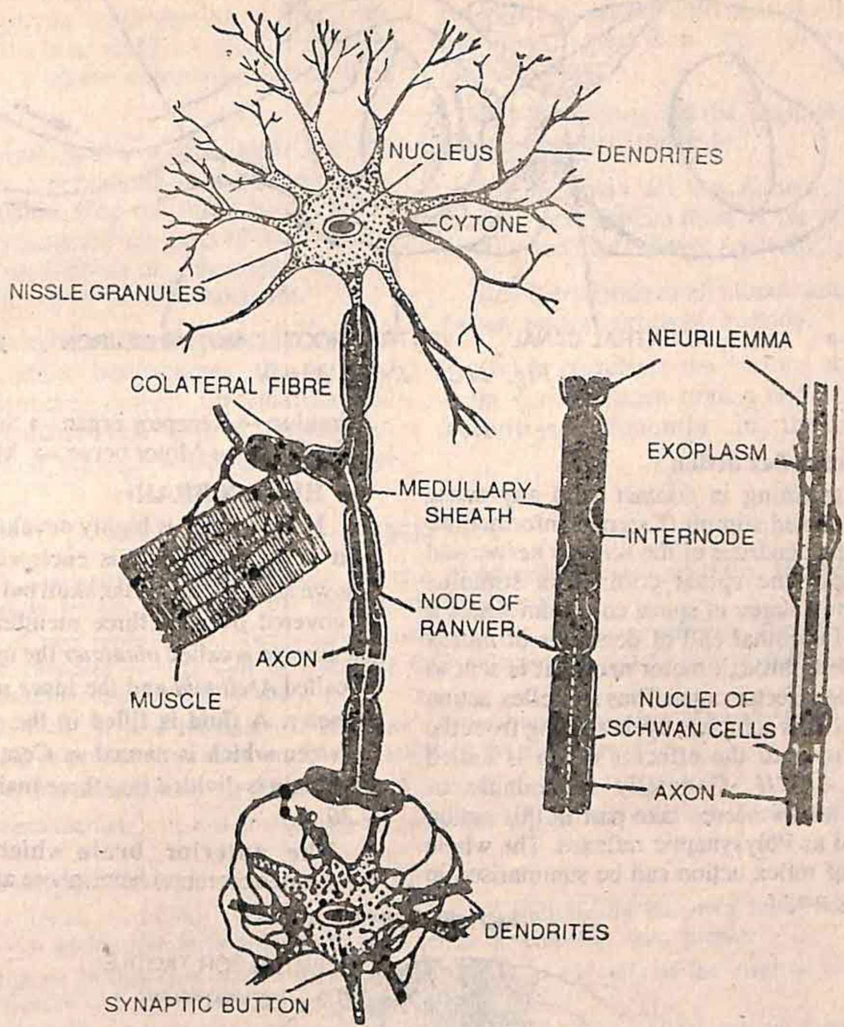
3. *Autonomic Nervous System :* It includes the visceral motor fibres and somatic motor fibres. Both types of nerve fibres are the motor nerve fibre of spinal nerves.

The cranial nerves and the spinal nerves do one way function. So they are divided into two types : (*i*) *The sensory nerves* which receive the impulse from the organ and carry it to the brain and spinal cord. (*ii*) The Motor Nerves which carry the responses from brain or spinal cord to the effector organ. Both types of nerves are structurally alike.

Structure of the nerve cell or neuron :

Neuron is the unit of Nervous system. Each neuron (Fig 4·28) is mainly divided into two parts – the *Cyton* and the *Axon.* Cyton is the broad part filled with cytoplasm, nucleus along with a network of neurofibrils, mitochondria, golgi complex and Nissle's granules. The outer surface of the cyton is projected at various places throughout the surface which are called as dendrones. Each dendrone is further divided into fine branches which are called the dendrites.

Axon is the long tube. Dendrites and axon are covered over by a thin and transparent membrane known as *neurilemma.* This membrane is made up of long and flat *Schwan cells* which has a



(Structure of Neuron)
Fig. 4·28

nucleus in the Centre. In between axon and membrane there is a thick layer of fat which is named as Myelin or Medullary sheath which is broken at some intervals which are known as nodes of Ranvier. The distal end of axon is bifercated. Each branch is further divided into fine branches which are known as terminal branches.

Transmission of nerve impulse : The main function of nerves is to receive the impulses from the sensory organs and carry them to the brain and spinal cord and the response of impulse is carried from brain or spinal cord or both to the effector organs.

The second main function of nerves is action potential *i.e.*, to hold those chemical activities inside the nerve fibre and at the synapse which are essential at the time of receiving the stimuli and transferring it from one nerve fibre to the other nerve fibre. These activities are Bio-electrical in nature and are called the action potential.

Reflex arc and reflex action

Reflex action is the involuntary action which is done by the spinal cord. This action is very quick. It takes a fraction of a second. Though they are not without aim even then they are automatic (See *Fig. 4·29*).

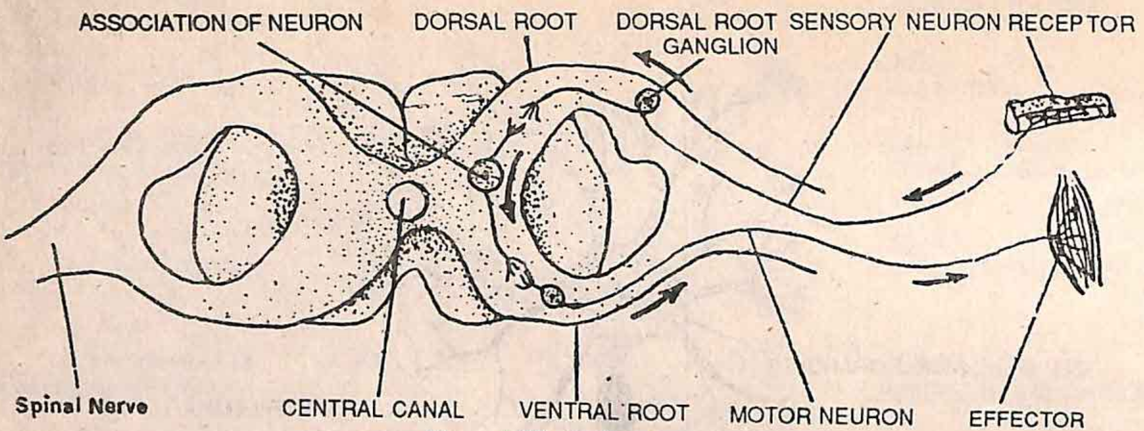


Fig. 4·29 Reflex Action

Mechanism of reflex action :

On coming anything in contact with any sense organ, the received stimuli (External information) is passed to the dendrites of the *sensory nerves* and is carried upto the spinal cord. This stimulus reaches the grey matter of spinal cord from where it is sent to the terminal end of dendrites of *motor nerve* and then through motor nerves it is sent to the concerning effector organ.Thus the reflex action is completed. This complete cycle starting from the sensory organ upto the effector organ is called ***REFLEX ARCH***. Generally the bundle of sensory and Motor nerves take part in this action so it is called as Polysynaptic reflexes. The whole mechanism of reflex action can be summarised in the following way :

Stimulus → Receptor organ → Sensory nerve → Spinal cord → Motor nerve → Muscle action.

4.9 HUMAN BRAIN

Human brain is highly developed and evolved part of spinal cord. It is enclosed in a bony box known as skull. Inside the skull but outside the brain is covered over by three membranes - the outer membrane is called *piamater* the middle membrane is called *Archnoid* and the inner membrane is ***Duramater*****. A fluid is filled in the space present in** between which is named as Cerebro spinal fluid. The brain is divided into three main parts (*See Fig. 4.30*)

1. The anterior brain which includes the cerebrum or cerebral hemisphere and Diencephalon.

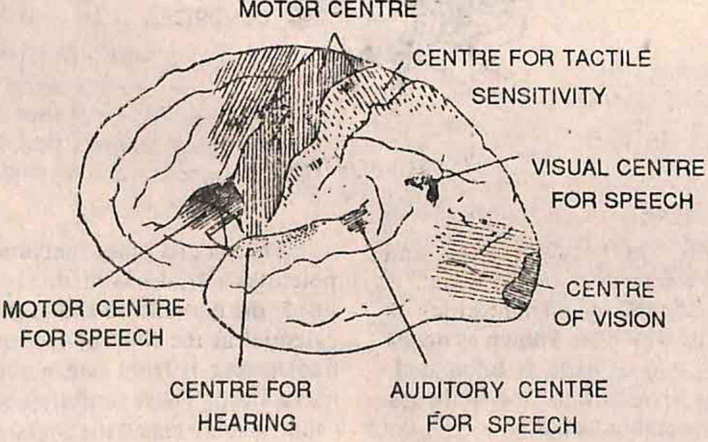


Fig. 4·30 Human Brain

This area is very important as it controls over the consciousness, storage and memory of information.

2. The **mid brain** which includes cerebral peduncle and corpora quadrigemina. It lies in the bottom part of the head and back of it. It controls and coordinates accurate movements and skill of work.

3. The **hind brain** which includes the cerebellum, pons and medulla oblongata. All these parts help in controlling the heart beats, blood vessels and breathing. All the parts of the brain are hollow. The brain consists of grey matter towards outside and white matter towards inner side.

Cerebral hemisphere controls particular parts of the body. The small hemispheres, the parts of cerebral hemisphere, collect information and experiences, in association centres. Feelings of consciousness and abstract intelligent behaviour thinking and abstract feelings etc., are controlled by this part of the brain.

Functions of brain : No doubt, the brain is the controller of all the activities of all the organs of the body even then, the following specific functions are :

(*i*) It receives all the impulses from all the sensory organs of the body.

(*ii*) It stores all the informations which it receives and applies them at the proper time and activity and thus behaves accordingly.

(*iii*) It responds to all stimuli and impulses sent by any sensory organ of the body.

(*iv*) It correlates the various stimuli received from various sense organs and co-ordinates the activities efficiently in the whole body.

SUMMARY

Growth is a vital activity in which weight and size of the cell increases gradually. It reflects the increase in weight and size of the living being day-by-day.

Growth is of two types — (1) Temporary growth and (2) Permanent growth. The process of growth involves — (*a*) Cell division (*b*) Cell enlargement (*c*) Cell movement (*d*) Cell differentiation and (*e*) Cell death. .

Reproduction — It is a fundamental character of the living organism through which a new offspring is produced to carry on the characters of the same species.

Two types of Reproduction — (1) Asexual and (2) Sexual

Asexual Reproduction : In this method no reproductive organs are involved. Fertilization does not occur.

Important methods of Asexual Reproduction :

1. *Binary fission* — In this type, the nucleus divides amitotically into two followed by the cytoplasm giving rise to two daughter cells which develop like their parents.
2. *Budding* — In this type small outgrowth (bud) grows at any side of the matured cell. This bud develops and gets detached from the parent cell.
3. *Fragmentation :* In this method the whole living's body is cut into pieces. Each piece develops to give rise a new organism.
4. *Sporulation* — In this method, a plant part contains bulbus blunt end which contains numerous single-celled structure 'the spores'. These spores germinate and give rise to new plants.
5. *Vegetative Reproduction* : Two main methods of this type of reproduction :

   (*A*) Natural method (B) Artificial method

   Leaf Propagation — As in Bryophyllum

   Bulbils – As in Oxalis and Agava.

   (*B*) *Artificial method* — (*a*) Cutting (*b*) Budding (*c*) Layering (*d*) Grafting (*e*) Gootying

   Tissue Culture – It is also a method of vegetative reproduction.

Sexual Reproduction : In this type, — male and female reproductive organs take part in this process to give rise to the offsprings. It occurs in plants as well as in animals.

In plants for the commencement of the sexual reproduction after maturation of male and female reproductive gametes, the pollination occurs either in the same flower or in other flowers through Cross pollination by utilizing any one of the following agents — air, water, insects and animals.

After pollination, fertilization takes place in which zygote is formed by the fusion of male and female gametes.

After fertilization fruits and seeds are formed.

Sexual Reproduction in Animals — In testes the sperms are formed which are the male reproductive gametes.

In ovaries, the ova are formed. Each ovum is the female reproductive gamete.

The sperm fuses with ovum to form Zygote. This process of fusion is called fertilization. The Zygote is converted to young ones.

QUESTIONS

1. **Define the following terms :**
   (*i*) Sexual reproduction (*ii*) Vegetative propagation (*iii*) Endocrine system (*iv*) Tissue culture (*v*) Menstrual cycle (*vi*) Double fertilization (*vii*) Pollination.

2. **Answer the following either in one word or in one sentence only :**
   - (*i*) Which is responsible for the general growth of the body ?
   - (*ii*) In which type of reproduction tissue culture is placed ?
   - (*iii*) Which controls the general growth of the plant ?
   - (*iv*) Who is responsible for diabetes disease ?
   - (*v*) Which hormone is responsible for the regaining the position of uterine muscles after delivery ?

3. **Write the expanded forms of the following :**
   (*i*) L.H. (*ii*) A.D.H. (*iii*) L.T.H. (*iv*) F.S. H. (*v*) C.A.M.P. (*vi*) A.M.P. (*vii*) A.C.T.H.

4. **Write the correct situation of the following glands in the human body :**
   (*i*) Pituitary gland (*ii*) Islets of Langerhans (*iii*) Adrenal gland (*iv*) Thymus gland (*v*) Parathyroid gland.

5. **Give the brief description of the following :**
   (*i*) Myxoedema (*ii*) Goitre (*iii*) Hyperglycaemia (*iv*) Dwarfism (*v*) Cretinism (*vi*) Hypoglycaemia (*vii*) Diabetes

6. **Long Questions :**
   - (*i*) Describe the functions of Plant hormones.
   - (*ii*) Describe the mechanism of travelling of impulse in the Neuron.
   - (*iii*) Why does the Pituitary gland call as master gland ?
   - (*iv*) What do you mean by secondary sexual characters ? Write the secondary sexual characters formed in male and female homo-sapiens.
   - (*v*) Describe the double fertilization triple fusion occur in angiospermic plants.
   - (*vi*) What do you mean by reflex action ? Explain it with the help of an example.
   - (*vii*) Explain all the activities of growth in the living organism.
   - (*viii*) What do you mean by sporulation ? Explain it in detail with an example.
   - (*ix*) What is Natural Vegetative Propagation ? Explain all types with examples.
   - (*x*) Describe the importance of vegetative propagation.

7. **Differentiate the following :**
   - (*i*) Budding in animal and budding in plants.
   - (*ii*) Grafting and budding.

(*iii*) Function of brain and spinal cord.

(*iv*) Viviparous and oviviparous animals.

(*v*) Pollination and fertilization.

(*vi*) Growth in plants and growth in animals.

8. Digrammatic Questions :

(*i*) Draw a neat and labelled diagram of Nerve cell or Neuron.

(*ii*) Draw a labelled diagram of the internal structure of ovary of a flower.

(*iii*) Draw a labelled diagram of male reproductive organs of man.

(*iv*) Draw a labelled diagram of female reproductive organs of homo-sapiens.

(*v*) Draw a labelled diagram of a mammalian sperm.

9. Fill in the blanks with appropriate words :

(*i*) The life span of a sperm is .... hours.

(*ii*) The unfertilised egg can survive upto............ hours after ovulation.

(*iii*) The process in which .... attaches with the endometrium of uterus is called as ....

(*iv*) .... controls the secondary sexual characters in male homo-sapiens.

□ □

CHAPTER 5

STUDY OF BIRDS

LEARNING OBJECTIVES

At the completion of this Chapter, you should be able to learn

1. The meaning of ornithology.
2. Two main groups of birds — (A) Neornithes (B) Palaeognathae.
3. About 8600 species of birds are known uptil now out of them 1265 species are found in India.
4. Classification of birds is based on several characters out of all, the shape of feet, beaks and wings are important.
5. The meaning and aims of pairing the male and female birds.
6. **The meaning of 'Roosting' and its aims.**
7. The meaning of Perching in the birds and its mechanism.
8. The meaning of migration and its purpose.
9. Significance of Bird's study.

INTRODUCTION :

You will find animals everywhere in the world but all animals are not found everywhere. On the other hand there is hardly any place where birds are not present. That is why birds are the best known and easily recognisable. They are found in the fields, forests, grasslands, mountains, deserts, marshy places and in water. They are liked by all due to their large varieties of body colour, melodious sounds, beaks, toes etc. They also give the indication to the people about the day dawn by chirping. In this way man is closely associated with birds since long. Therefore, a world would be as sad without birds as one without sunshine.

The study of birds is known as 'Ornithology'. Dr. Gadow has said regarding birds as *they are oviparous, warm-blooded amniotic vertebrates which have their forelimbs transformed into wings, metacarpus and fingers carrying feathers and also have maximum four toes of which the first toe is the 'Hallux.'* (See Fig. 5·1).

Dr. Salim Ali was the first Indian who studied birds for the first time and wrote a book "The Indian Birds". He himself had no guidebook. He learnt all about the birds through first hand observation.

5.1 General Characters of Birds :

1. All the birds come under one group 'Aves'.
2. They are vertebrates *i.e.*, having a vertebral column.
3. The whole body is divided into head, neck and trunk.
4. The head bears a pair of eyes, ear holes and mouth.
5. Mouth is converted into horny beak which is devoid of teeth in both the jaws.

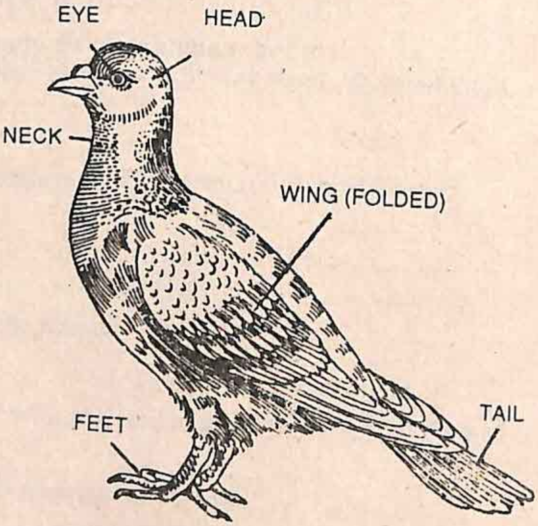


Fig. 5·1

6. The forelimbs are modified into wings which help into flight.
7. The whole body is covered over by three types of feathers *i.e.*, down feather, contour feather and filoplume feather.
8. Tail is present throughout the life which is covered by long feathers.
9. The hind limbs are covered by scales and each foot has four toes.

10. Bones are hollow and light in weight which help in flight.
11. The heart is four chambered.
12. They are warm blooded and so they maintain their body temperature constant.
13. They are unisexual.
14. Fertilization occurs inside the female body.
15. They are oviparous *i.e.*, lay eggs.
16. The feet are non-conductor of electricity.
17. They have the perching mechanism.
18. They have air bladder attached with lungs which help in flight.

Types of Birds : Though, there are several variations in birds in their shape, size, colour, mode of feeding and ecologically but on the basis of flight they are categorised into two groups—(1) Flying birds and (2) Flightless birds.

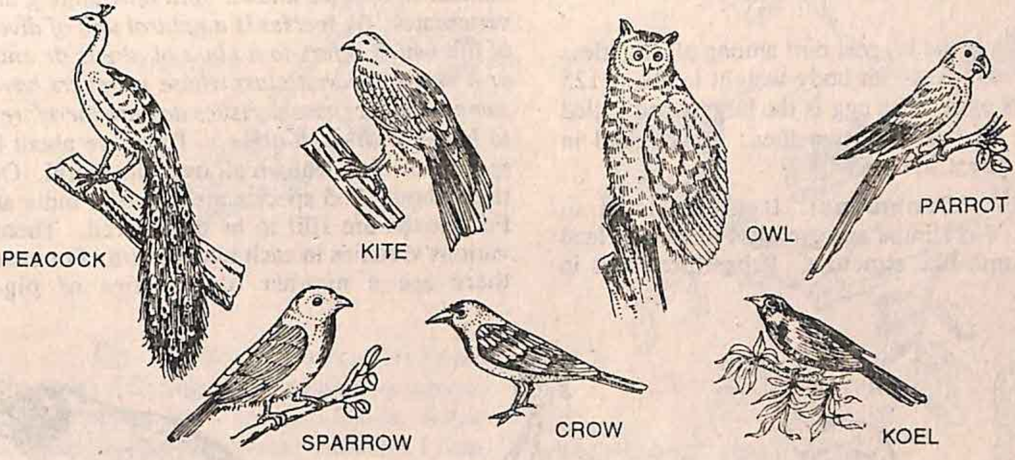


Fig. 5·2 A few common flying birds.

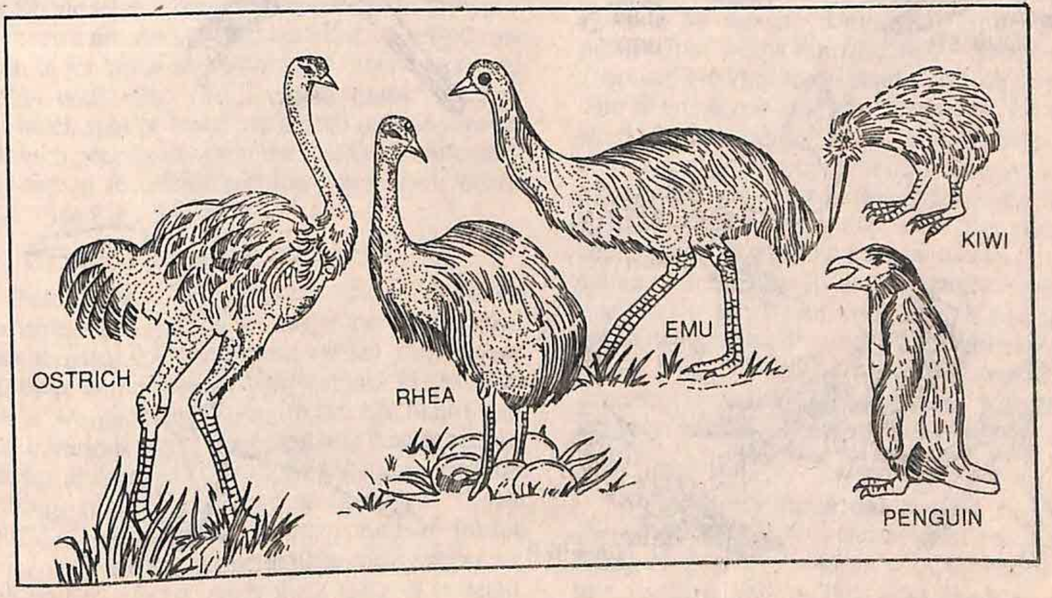


Fig. 5·3 Some flightless birds

1. Neornithes or flying birds :

The birds of this group are called as modern birds which are found in all the parts of the world. All fly in the air (Fig. 5·2).

2. Palaeognathae or flightless birds :

The birds coming under this group are generally large in size. Though they have wings but are helpless in flight due to less development and curved feathers. Ostrich (Rhea), Penguins, Emu and Kiwi are the famous flightless birds (Fig. 5·3).

Ostrich is the biggest bird among all flightless birds. It runs fast. Its body weight is about 125 kg. It lays eggs. The egg is the largest one celled structure. It has only two toes. It is found in America, Africa and Asia.

EMU (Dromaeus): It is restricted to Australia. Forelimbs are greatly reduced. Head bears a comb-like structure. It has three toes in each foot.

Penguin : It is found in Antarctica (Southern pole). Generally it is brown dorsally and white ventrally. Its wings are modified into swimming paddles. It lives in cold sea water or on ice. The hind limbs have folds of skin where it keeps its eggs, and incubates them. Generally they do not build their nests.

Kiwi (Apteryse) : It is generally found in Newzealand and adjacent islands. Its feathers are simple hair or bristle like. Its wings are vestigial.

5.2 KINDS OF BIRDS : Birds have the largest number of species known uptil now among all the vertebrates. (*A species is a natural unit of diversity of life which refers to a class of plants or animals or a variety of that class whose members have the same common characteristics and are therefore able to breed with each-other.*) There are about 8600 species of birds known all over the world. Out of them about 1265 species are found in India alone. Few dozen are still to be discovered. There are various varieties in each kind of bird. For example there are a number of varieties of pigeons

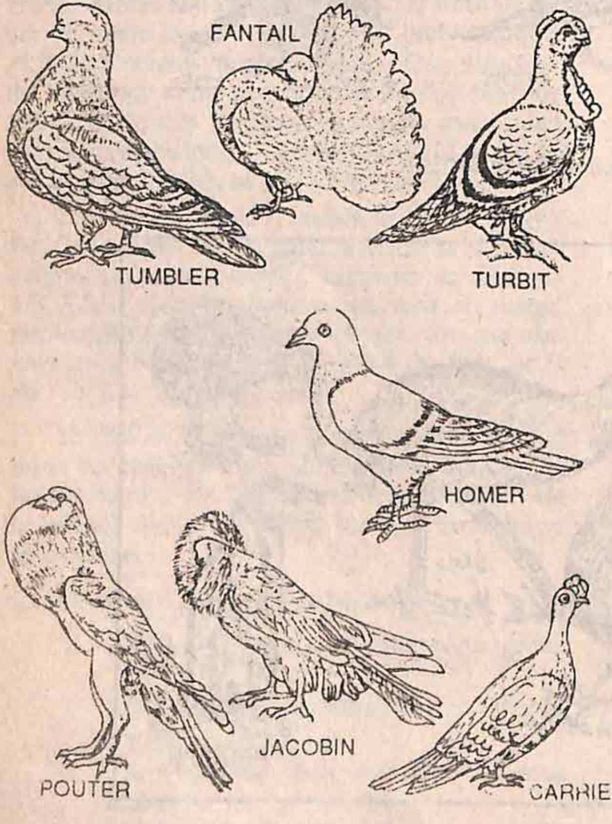


Fig. 5·4 Kinds of Domestic Pigeons

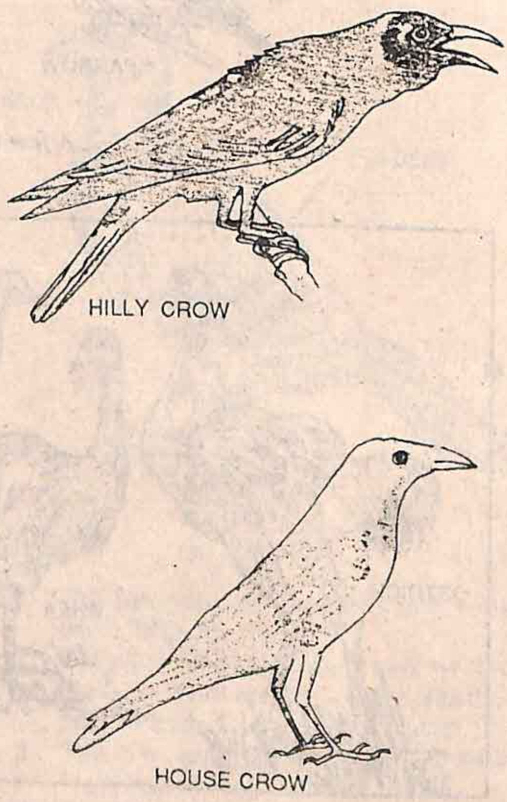


Fig. 5·5 Kinds of Crows

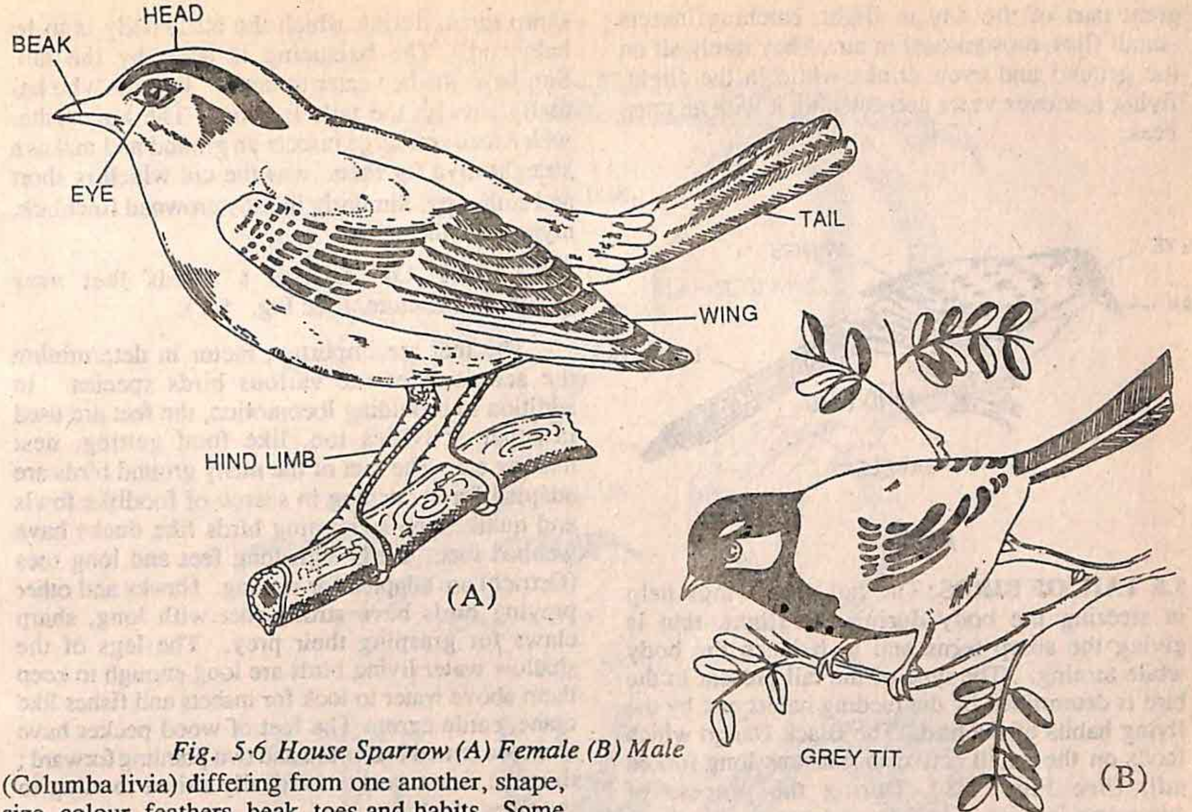


Fig. 5·6 House Sparrow (A) Female (B) Male

(Columba livia) differing from one another, shape, size, colour, feathers, beak, toes and habits. Some prominent varieties are—Girahbaz (Carrier), Lotan (Tumbler), Mukhi, Lakka (Fantail), Shirazee, Baghdadee, Pouter etc. (See Fig. 5·4). In the same way there are a number of varieties known of poultry bird like—white lighorn, Black minorca, Red Rhode island, Brownish chicken. In the same way crows are also of two varieties — hilly crow which is jet black and plain crow which has steel greyish neck (Fig. 5·5). Male house sparrow have black spot or beard patch with reddish, brown back with grey head while the female is uniformly light brown in colour and have not black beard patch. (See Fig. 5·6).

5.3 CLASSIFICATION OF BIRDS

Behaviour : The classification of the birds into orders or species is based on the several characteristics. Among these are the structure of feet, beak and wings. Modifications in the feet, beak or wings relate closely to the life habits and diets of various birds. Foot structure adapts certain birds for diving and others for swimming, wading, perching, running or carrying the prey. Beak modification determine whether bird is insect eating, seed eating, flesh eating, mud-prober or wood-prober. Let us study these features in detail with their appropriate examples.

5.4 WINGS OF BIRDS : A flying bird greatly resembles an aircraft. It has a fuselage, a body, covering planes wings, a rudder a tail, a carriage retractable in flight feet. The main work in flight is done by wings. Depending upon the flight pattern, the wings are modified. As they can be short and broad or long, slender and slightly curved. The short, broad wings are adapted for low and short distance flights, like in coppersmith, babbler and bulbul. The coppersmith is a small, fruit eating bird. It owes its name from the sound of Kuk-kuk which resembles with the sound of a coppersmith at work. As the coppersmith is a fruit eating bird, it has to fly short distances from tree to tree within short territory. Thus it has short and broad wings (See Fig. 5·7). Similarly *babbler* which feed on insects, have to travel the small distances from one tree to another within a small territory, have the small and broad wings (See. Fig. 5·7).

On contrary the long, slender and slightly curved wings are the characteristics of the fast flying birds who spend most of their time in air, like swallow and swifts. The swallow spend a great part of the day in flight, catching insects (small flies, mosquitoes) in air. They rarely sit on the ground and even drinks while in the flight, flying low over water and catching it with an open beak.

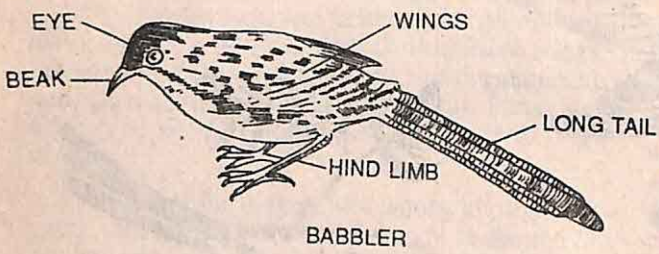


Fig. 5·7

5.5 TAIL OF BIRDS : The tail with wings help in steering the body during the flight, that is giving the sharp turns and to balance the body while turning. The type of the tail present in the bird is determined by the feeding habits and by the flying habits of the bird. The Black Dango which feeds on the small active insects has long forked tail, (See Fig. 5·8). During the process of capturing insects it has to undergo many short, sharp turns, during which the bird's body is to be balanced. The balancing is done by the tail. Similar is the bee-eater titmouse. In birds who has to fly slowly, the tails is short. The king-fisher which feeds on large insects on ground and makes a straight dive for them, was the tail which is short and stummpy. Similarly in ashy crowned finchlark, myna and others.

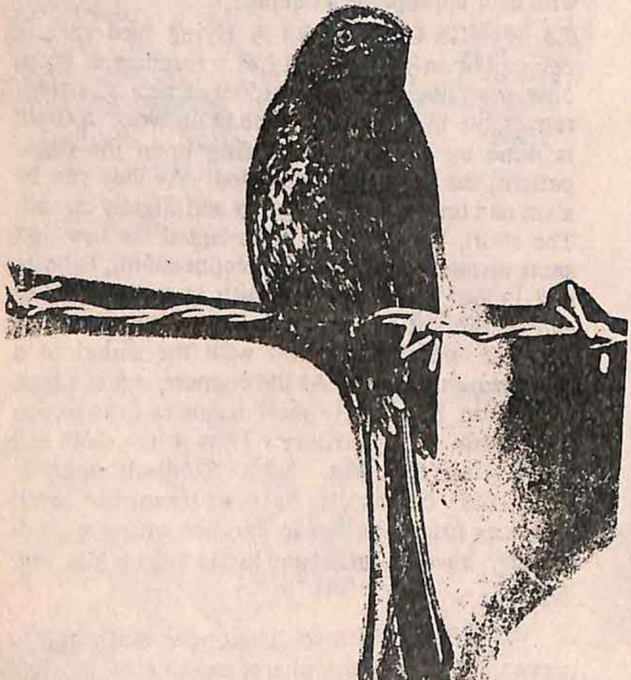


Fig. 5·8 The Black Dango

5.6 FEET OF BIRDS : Birds' feet vary greatly in structure. (See Fig. 5·9).

The feet are important factor in determining the activities of the various birds species. In addition to providing locomotion, the feet are used in other activities too, like food getting, nest making etc. The feet of the many ground birds are adapted for scratching in search of foodlike fowls and quail. The swimming birds like ducks have webbed feet. Birds with long feet and long toes (Ostrich) are adapted for wading. Hawks and other preying birds have strong feet with long, sharp claws for grasping their prey. The legs of the shallow water living birds are long enough to keep them above water to look for insects and fishes like crane, cattle egret. The feet of wood pecker have two toes turned backward and two pointing forward ; thus the wood pecker is ideally suited to cling to the sides of a tree.

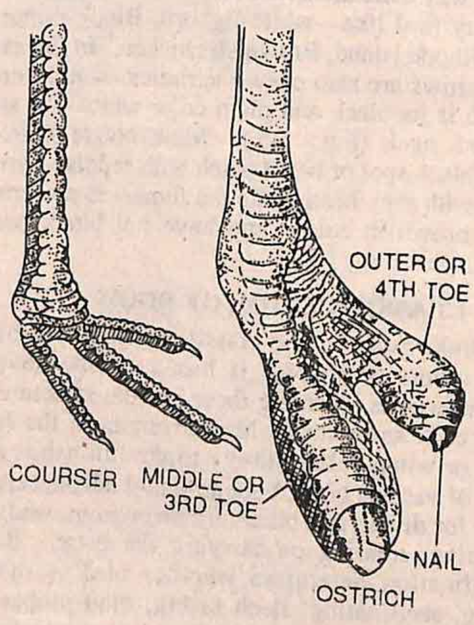


Fig. 5·9 (i) Birds' feet

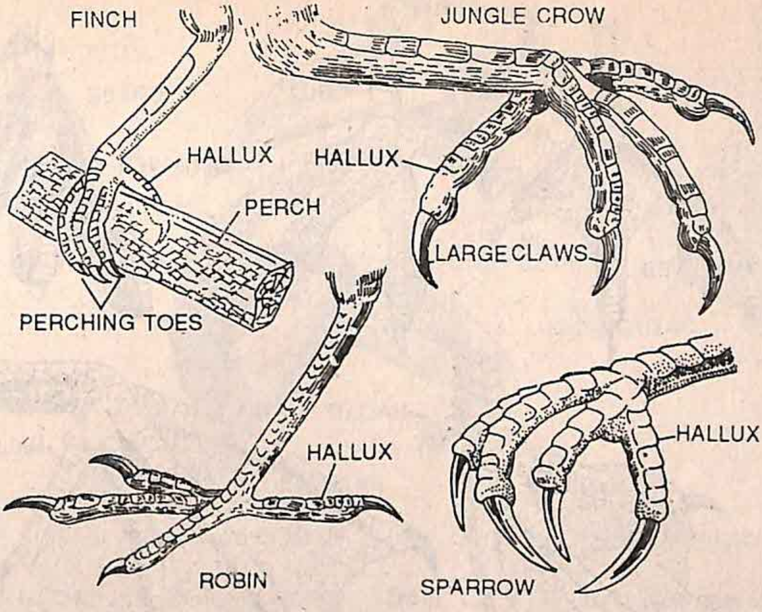
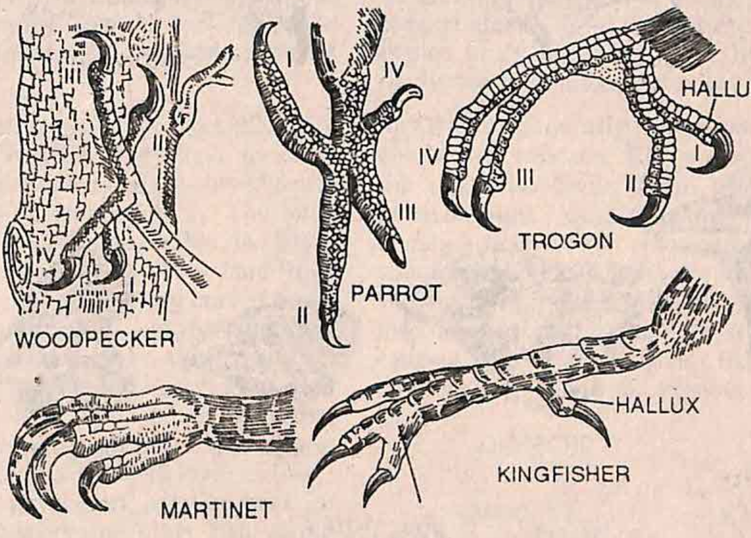


Fig. 5·9 (ii)



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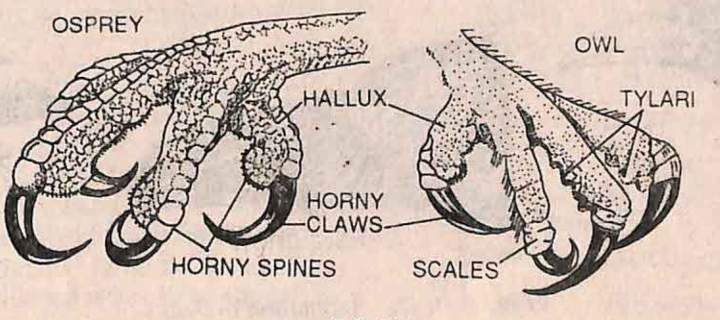


Fig. 5·9 (iv)

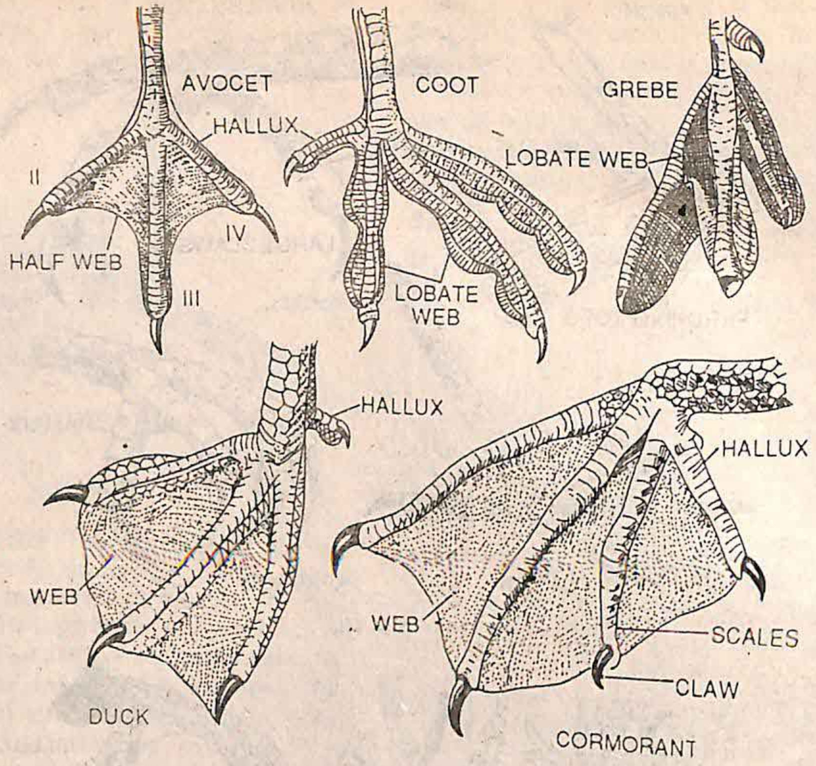


Fig. 5·9 (v)

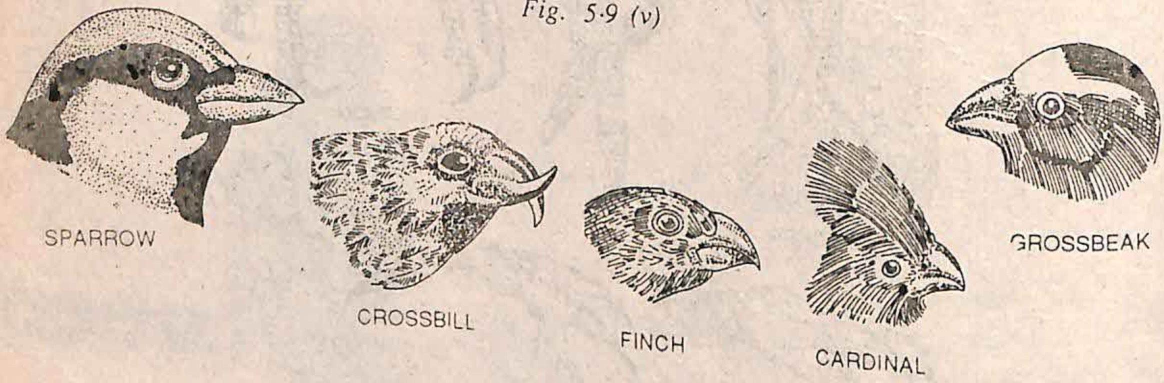


Fig. 5·10 (i)

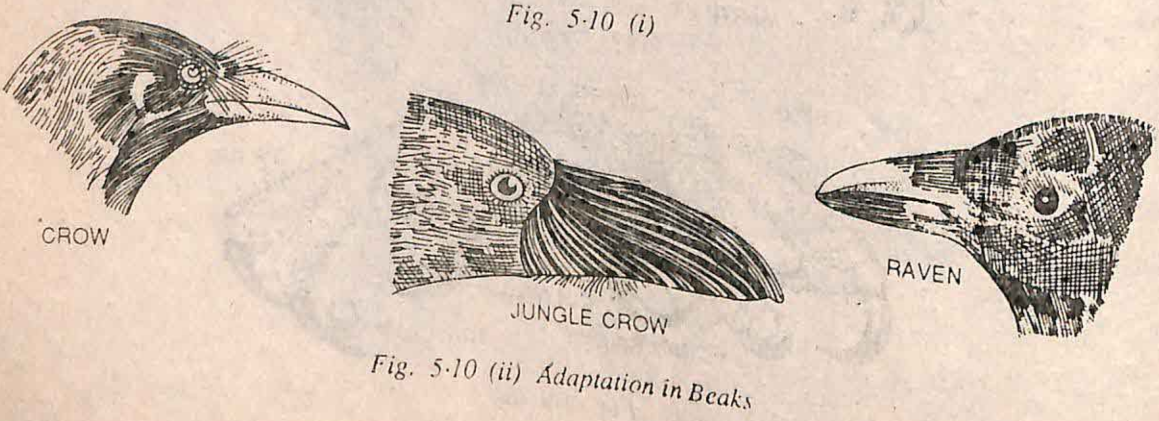
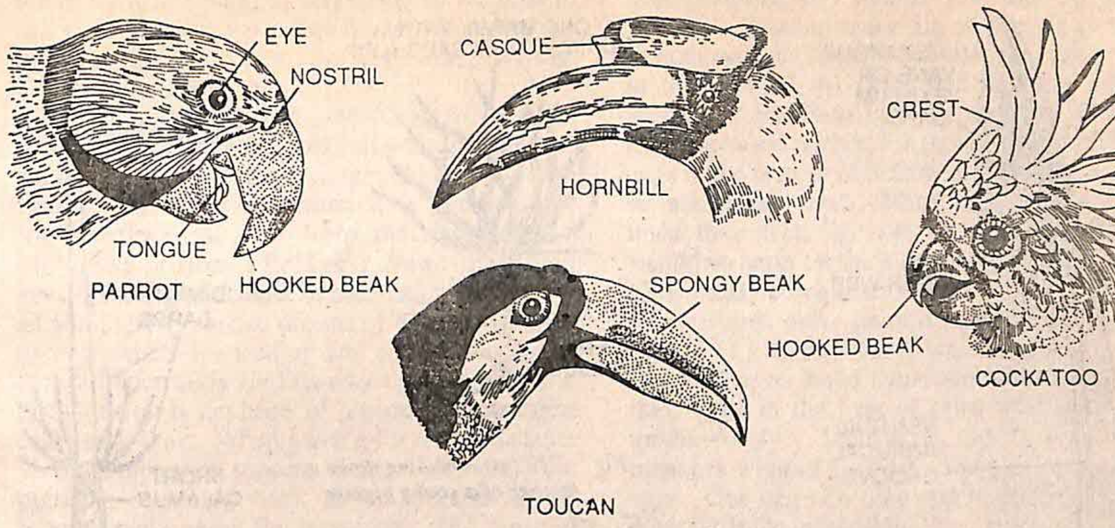


Fig. 5·10 (ii) Adaptation in Beaks



Adaptation of Birds *Fig. 5·10 (iii) Different shapes of Beaks*

5.7 BEAKS OF BIRDS: In birds teeth are absent and are replaced by horny beaks. The beak is the projection of the upper and the lower jaw. The shape of the beak varies from the bird species to species being determined by the feeding habits (See. Fig. 5·10)

As the birds which slips nectar especially from the tubular flowers in which they have to insert their beaks have long, slender and the curved beaks like the humming bird, and sun bird. The birds like parrot, hornbill, rose-ringed paraket, the beaks are strong and curved to penetrate thick hard fruits like green guava, apples. The strong curved beaks are also the characteristics of the birds of the prey who use their beaks to tear the flesh from the animal body, like kites *i.e.*, the Pariah kite. Red and white Brahmin Kite. The birds like crow, fowl, the omnivorous feeders has a simple strong pointed beak which can deal with all kinds of food ; sparrow and finches have short, peg like beak for eating seeds ; kingfishers and other fish eating birds have narrow beaks for grasping the fishes ; the aquatic birds have long flat beaks like duck and swans.

5.8 BEHAVIOUR OF BIRDS: The behaviour of birds is more diverse and complicated than the behaviour of frogs, fishes or lizards. Birds choose a convenient place for the nest, find appropriate material for its construction, build the nest, hatch nestlings, feed and protect them from enemies. All these activities are instinctive in birds. Instinct combine with new conditioned reflex in nestlings, from the very first day of their life. The unconditioned food reflex is displayed in a hatching in pecking. At first it pecks all the objects it sees, gradually, from its own experience the chick begins to discriminate edible from inedible and rarely makes mistakes thereafter.

Birds generally gain more and more conditioned reflexes. Recognise well the voice of the one who feeds them, orient well in the environment outside the poultry yard, distinguishing it from other buildings. The art of communication is well-developed in birds. Besides singing, birds produce many different sound signals indicating anxiety, fright, calls, warning of danger, causing a respective response from individuals of their species. As in the evening you would have heard

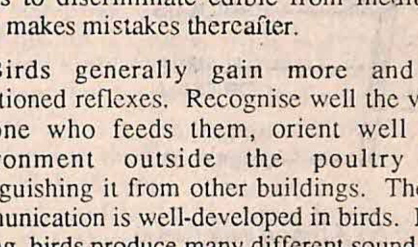


Fig. 5·10 (iv) Feathers of Pigeon

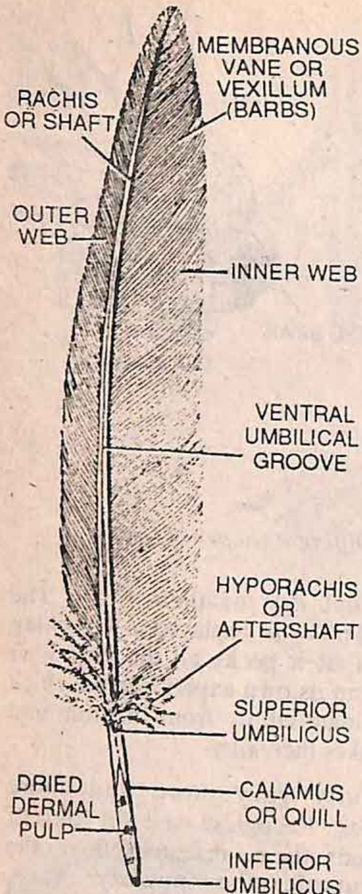


Fig. 5.10 (v) A typical quill-feather (remex) of pigeon in ventral view.

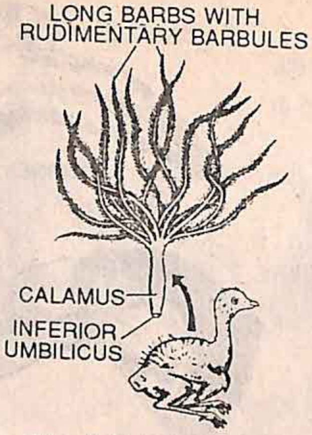


Fig. 5.10 (vi) A nesting down feather of a young pigeon

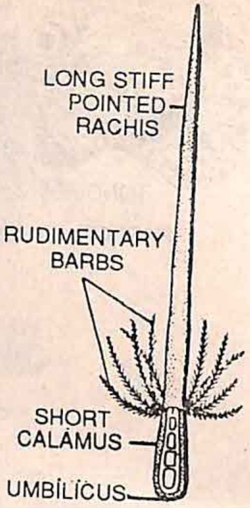


Fig. 5·10 (vii) Rictal bristle

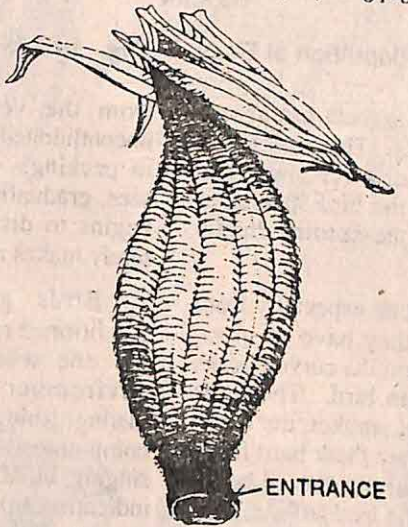


Fig. 5.11 (i) Nest of the Weaver Bird

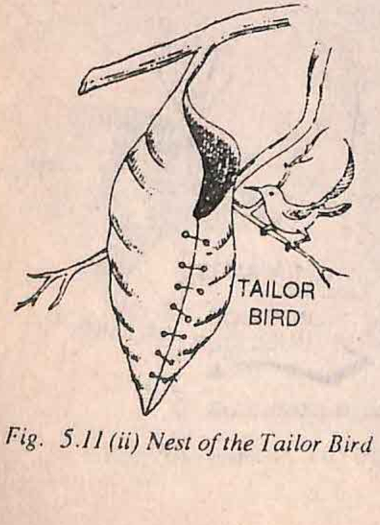


Fig. 5.11 (ii) Nest of the Tailor Bird

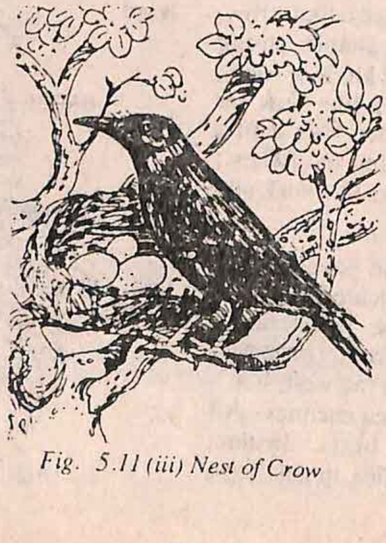


Fig. 5.11 (iii) Nest of Crow

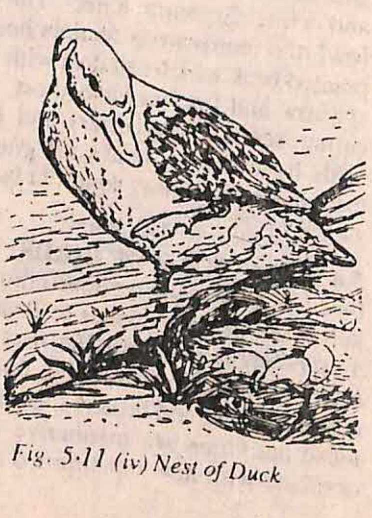


Fig. 5·11 (iv) Nest of Duck

the noisy aggregation of large number of birds to call their partners and companions, when they are preparing for night rest after a daylong moving. This is called roosting.

The language of birds which is different for each species, a man can make use of tape recorded warning cries of birds to frighten them away. For example, this is done when it is necessary to frighten flocks of birds from the runway of an aerodrome or from a field or garden. Birds have developed a special sense of orientation in space. If an adult bird is carried dozens of miles away from its nest, where its nestling are, and then released, the bird unerringly find its way back home. This phenomenon is the basis of pigeon post prevalent in ancient times. When leaving for a long distance journey, men took pigeons along with them. The pigeons, returning back to the pigeon house, brought news about the travellers. The sense of orientation is of great significance during the migration of birds which we will study later in this lesson.

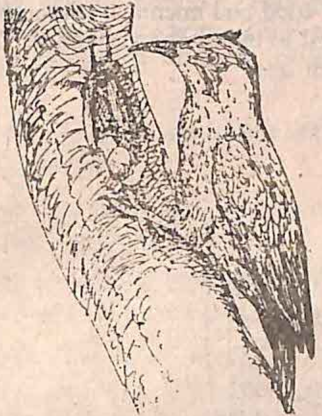


Fig. 5.11 (v) Nest of Woodpecker

5.9 PAIRING AND NEST BUILDING: The birds show differences in the pairing pattern and in nest building. Many birds pair only for one season, like geese and majority of song birds species. The males and female partner of ducks and pheasant stay together only upto the time when the eggs are incubated. Birds of prey and some others live in pair for many years.

The nest is the place made by the bird to lay its eggs in, using the twigs, moss, leaves and mud. The nest more often than not are built by the female ; but sometimes it is built by the males as in weaver bird, the male builds the nest. Quite often both the male and female cooperate in building the nest ; the male brings the material for nest building, the female sets and secures it. Whosoever should make the nest, male or female or both male and female but there is great diversity in the type of the nests built by the different species of the birds. Many birds of wood, for example wood-pecker, kingfisher, fly-catchers, lay eggs at the bottom of hollow in the trunk of a tree, or make a nest there. Many birds (ducks, cranes) make their nests right on the ground. Swifts and swallows nests on the side of a rock-cliff. Tailor birds neatly stitch their nests from the leaves, the weaver birds make its nest from the fibres. (See. Fig. 5·11). Certain birds which are nest parasite like koel never build their own nests but they slip their eggs in the nest of crow who hatch them unknowingly. Similar is the Cuckoo, which manages without the nest. The female lays 10-12 eggs. One egg at a time and in different nests of other birds for incubation.

The number of eggs in clutch is quite variable. Big birds of prey like eagles hatch only one egg. The hatching is done by both the male and female, replacing one another in the nest, while in certain cases like ducks only the female does it. Small birds hatch their eggs for about 14 days, larger birds somewhat longer. Thus, a chicken hatches her eggs for 21 days, while a swan and large predatory birds take about 1.5 months. Brooding birds turn their eggs around in the nest from time-to-time. This provides for even more warming, which aids in the fast development of the embryo. Some birds do not incubate their eggs at all like brush turkeys found in Australia, burry their clutch in the soil, where the embryo develops under the effect of the heat from the surrounding earth.

The nesting season is the crucial time in the life of birds and they should not be disturbed at this time. Frightened birds abandon their nests and then the nestling will perish.

Types of nestling : Nestling of ducks, geese, swans and poultry are hatched covered with feathers and with open eyes. Several hours after hatching or on the next day they leave the nest and even run behind the mother. These young birds are called *precocial or nudifugous.*

Despite their independence, the young birds need some warming during the first few days of their life and hide frequently beneath the mother's wings, because their body temperature do not stabilize immediately. The offspring of birds of prey, ravens, rooks, pigeons, woodpeckers, parrots, all song birds and many other nestlings hatch helpless with fused eyelids and closed ear operation.

Their body is naked or is covered with individual patches of fine feathers. They are incapable of locomotion and remain in the nest for long time. These young birds are called *altricial or nudicolous*. The nudicolous young ones are fed by the parents even when they leave the nest and start to flutter from one tree to another. The parents stop feeding the young ones when the latter start to fly independently.

Care of young : Care of the young ones is quite complex, especially care of young birds who remain in the nest for a long time. The parents warm and feed them, making about 400 rounds a day with food ; they protect them against overheating by sunbeams if natural shade is not available, a parent stand with open wings over its offspring in the hot time of the day. The parents regularly carry away the dung of the young in order to keep the nest clean. The adult birds protect the zealously when an enemy appears. If a bird of prey walks or flies near the brood, the parents raise the alarming clamour, the neighbouring nesting pair join in, and together they all go after the intruder so that he is forced to retreat. Sometimes mother tries to draw the attention of a man away from her nest, pretending to be wounded. When the enemy tries to grab her, she flies further and further away, and then disappears.

5.10 ROOSTING

Birds are independent for their activities. They move here and there throughout the day in search of food. In the evening they assemble at one place on trees. They start chirping and amusing. *The process of gathering them at one place is called Roosting.*

The main aim of roosting is to take rest without fear, pass the night time and to enjoy in their society. Though all birds roost but their habit of roosting varies from species to species. They can be active only upto twelve hours a day including night. So the birds which are active in day roost in night and vice-versa. Some birds roost individually while some roost in groups. For instance, Koel (Nightingale) roosts singly. Sparrows, Kite, Vultures, Pigeons etc., roost in groups. Group roost is advantageous. In groups birds get heat from each other. Some birds give information to others regarding danger, good sources of food and enemies. Some birds in the group guard to others from enemies. They enjoy in their own way.

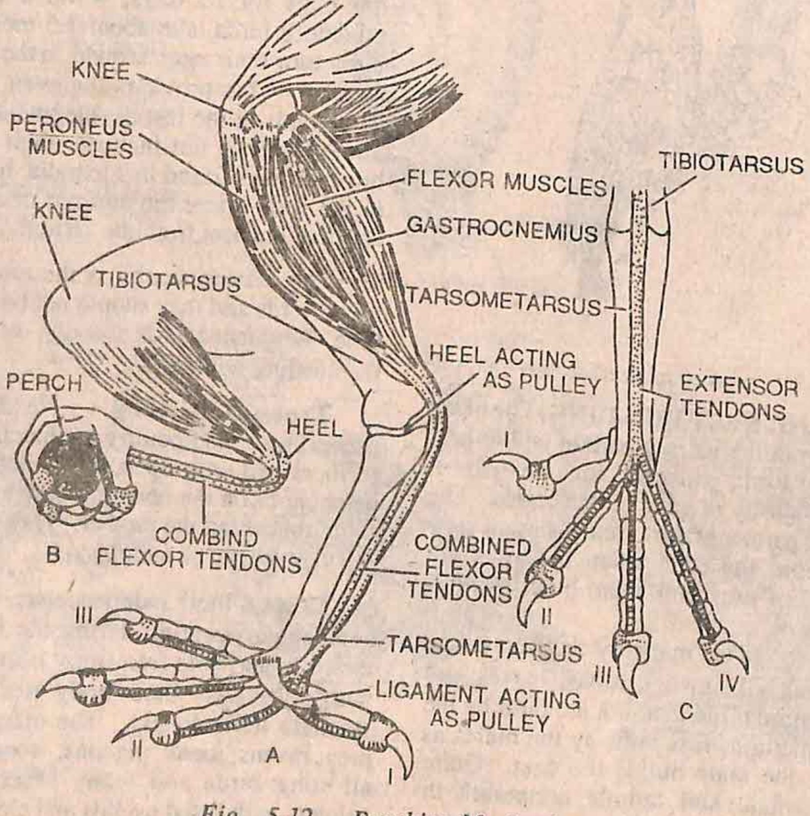


Fig. 5·12 Perching Mechanism

Perching : *It is a process in birds when it sits on the branch of tree or electric wire or on rod its toes mechanically flexed and grasp the perch without any special effort.* It is a characteristic features found in birds. There are special muscles in the pelvic region and in hind limbs which perform this function. So these muscles are called as perching muscles. (See Fig. 5·12).

The arrangement of these muscles in the body is called as perching mechanism. Ambiens, Gastrocnemius, Peroneus longus, Flexor muscles and Extensor muscles are important perching muscles found in the hind limbs.

5.11 MIGRATION : *The movement or displacement of the birds in special unfavourable season and reappear on the same place in the favourable season is called 'migration'.* Though many animals migrate but to the neighbouring places but birds migrate upto very long distances from one country to the other country in a definite season for a definite period and go back after passing certain period. This process is regularly conducted every year. There are certain purposes for migration of birds which are as follows :

1. Birds migrate for passing the unfavourable seasonal time.
2. Birds migrate for laying and hatching eggs in certain climate.
3. Birds carry the messages from one country to the other regarding seasons.
4. Birds always lay eggs at their home places. So they returned to their home places when the favourable season comes back.

There are some birds which generally come to India in winter season and go back to their country in summer. In the same way some Indian birds leave their home in the beginning of summer and return in the beginning of winter. For example, Wagtail, Rosy Pastor etc.

There are some birds which migrate from one region to the other region. For instance the Arctic tern travel about 11000 miles from the coast of Labrador to America in winter. Storks also migrate from North Europe to South Africa. Migration can be studied by ringing or banding method. In this method the date, place and other information is written on a paper which is tied with the hind limb. The bird is then allowed to migrate. If that bird is spotted, it is trapped and received all the information. The other information from this side is again tied with the foot which is received by the scientists of the other country.

Significance : A question arises in the mind that why should we study birds ? In response to the answer of this question, there are many things about birds that appeal to people which are as follows :

1. Many things are obtained from birds like eggs of hen and duck, different types of feathers which are used in decoration and in medicines.
2. Birds are much associated with mankind. They all are more fascinating in their lives. They show good tenderness and solicitude in the care of their young ones.
3. Man got idea about flight in the air by seeing birds flying in the sky.
4. The bird's nest also gave idea to man to build his shelter keeping all the facilities in view. Man also got idea of living together with peace.
5. Many birds help to man in scavenging the dead bodies of the large animals. Vultures, kites and other adjacent storks serve as scavengers.
6. Man has worshiped the birds as the symbols in art.
7. Flesh of some birds are eaten by man. Cock, chicken, wild pigeons, water bird, *titar, bater* etc., are generally eaten by man.

Looking up into the importance of the birds we should take care of them. About 78 species of birds have disappeared in modern time. Government should frame some rules for the safety of the life of the birds. Hunting of the birds should be prohibited.

SUMMARY

Ornithology: It is the branch of Biology which deals with the birds. Dr. Salim Ali was the first Indian who studied birds for the first time and wrote a book "The Indian Birds". He learnt all about the birds through first hand observations.

All the known birds are classified into two groups — (A) Neornithes or Flying birds (B) Palaeognathae or Flightless birds.

Birds have the largest number of species known uptil now among all the vertebrates.

There are about 8600 species of birds known all over the world out of them about 1265 species are found in India alone.

There are various varieties of each kind of bird differing from one another in shape, size, colour, feathers, beak, toes and habits.

The classification of birds into species is based on the several characteristics. Among them are the structure of feet, beaks and wings. Their modifications relate closely to the life habits.

Pairing and Nest Building: Many birds pair only for one season like Geese and majority of song birds.

The nest is the place made by the birds to lay eggs in using twigs, moss, leaves and mud. Mostly the nest building is done by the female.

Nestling of ducks, geese, swans, poultry etc., hatched, covered with feathers and with open eyes. On the next day, they leave the nest and run after their mother. These young birds are called *Precocial* or *Nudifugous.*

In some species of birds, the young ones need some warming during the first few days of their life and hide frequently beneath the mother's wings because their body temperature do not stabilize immediately. Their body is naked or is covered with individual patches of fine feathers. These young birds are called *Altricial* or *Nudicolous.*

Roosting : Birds in the evening assemble at one place on trees. They go on chirping and amusing. This process of gathering them at one place is called roosting.

Perching : The process of gripping the resting place with toes without any special effort is called perching.

Migration : The displacement of the birds in special unfavourable season and their reappearance on the same place in the favourable season is called migration.

Significance of Bird's study : Birds have been proved very useful to mankind. Many things like feathers, bones, flesh, eggs etc., are obtained from them. They are closely associated with mankind. Man got idea of flight in the air from birds. He got the idea of making shelter from the birds. Many birds help in scavenging the dead bodies of large animals. About 78 species of birds have disappeared in modern time. Hunting of the birds should be prohibited.

QUESTIONS

1. **Define the following :**
   (*i*) Migration (*ii*) Perching (*iii*) Nudicolous birds (*iv*) Nudifugous birds (*v*) Oviparous animals.
2. **How will you distinguish between :**
   (*i*) Nudicolous birds and Nudifugous birds (*ii*) Male peacock and Female peacock
   (*iii*) Male sparrow and female sparrow.
3. **Give the answer of the following either in one word or in one sentence :**
   (*i*) Which bird lays the largest egg ?
   (*ii*) Write the name of the national bird.
   (*iii*) How many species of birds are known in the whole world ?
   (*iv*) How many species of birds are found in India only ?
   (*v*) What is the effect of electricity on the bird while sitting on an electric wire ?

(*vi*) Write the name of the largest bird and the smallest bird.

Long Answer Questions

4. What do you mean by roosting ? Write its advantages to birds.
5. Write the main characters of birds (Aves).
6. What is the advantage of having beak of different shape and size ?
7. Write the names of any three flightless birds.
8. What do you mean by perching mechanism ? Write the names of perching muscles.
9. Why do some birds migrate ?
10. What is the significance of the study of birds ?
11. What is nest ? What is its utility to the birds ?
12. Explain some (three) nests of different shapes. How do they form ?
13. What are the main contents of the nests ?

❑ ❑

UNIT IV

CHAPTER 6

HUMAN BEINGS

LEARNING OBJECTIVES

At the completion of this chapter you will be able to answer:

1. T.H. Huxley wrote a book "Man's place in the Nature".
2. In 1871 Charles Darwin also wrote a book "The Descent of Man".
3. Among mammals shrews took place first which were insectivorous.
4. Lemures descended from shrews.
5. The group Tarsioids evolved from Lemuroids which were very much similar to monkeys.
6. Anthropoids originated about 40 million years ago.
7. About 25 million years ago, the group 'Homonidae' evolved.
8. Homonids were considered as the ancestors of Apes and man.
9. Man is the highest animal due to the presence of certain characters.
10. Evolutionary stages of Man:

    Homonidae — 1. The Australopithicine stage.

    2. The Pithacanthropine Stage — Java man, Atlantic man, Homo habilis.
    3. The Neanderthal stage.
    4. The Modern Stage – Modern man.
11. The role of man in exploiting the environment :

    Human population is increasing day-by-day.

    Need of food and shelter is increasing.

    Man is establishing new industries and constructing new residences.

    He is utilizing fertilizers for growing more crops.

These all are making imbalance in the population per capita density in urban area and in rural area. Due to overpopulation, there is struggle for existence among people. They are using bacteria bomb, chemical bombs and other fatal weapons. Several types of diseases have taken place. Due to more industrialisation and overpopulation - air, water and soil pollution has increased. The carbon dioxide quantity has increased on earth which is producing excess of heat on earth.

INTRODUCTION

Like other mammals of present time, man also evolved from animal which was more simpler than any of us. But it is a false story regarding the evolution of man. No body could give the scientific evidence. All hypothised about it. In 1863, T.H. Huxley made some scientific attempts and tried to explain the origin of man in a book 'Man's place in Nature' written by him. Later on in 1871 Charles Darwin wrote a book 'The Descent of Man' in which he also explained the origin of man without any collection of facts from fossils or remnants. He hypothised only on the basis of the similarities of the present man with other animals like monkeys, apes etc. That is why, he suggested that man, monkey and ape also have the common ancestor (See Table 6.1). The mammals became distinct from the reptiles after about 10-70 million years from earth's history of life on it.

6.1 EVOLUTION OF APE AND MAN

Among the early mammals a group of insectivora took to the trees which were called 'TREE SHREWS'. No doubt. Not a single shrew of that time is present but with the help of present shrews, some of their characters can be assumed like sensitive long nose and sensitive ears. They had good balancing sense.

To depend upon the eyes and ears than nose, they must have realised and felt the necessity of grasping type of hands and feet. Our fossil record shows that lemure descended from shrews. The group of lemurs is called 'Lemuroids'. The lemurs of present time live on trees, having grasping hands and walking feet, flat snout with short nose, large eyes, long bushy tail (Fig. 6.1).

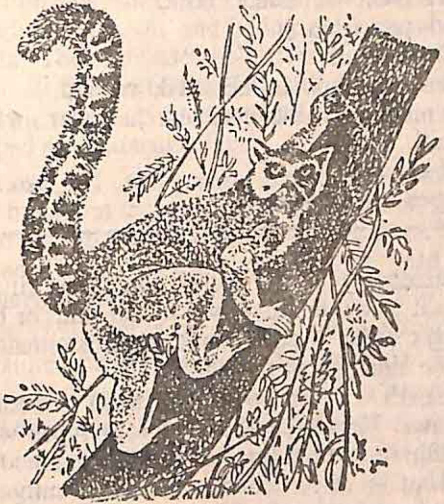


Fig. 6·1 Lemur—Ring-tailed lemur

Another group 'Tarsioids' evolved from 'Lemuroids'. The members of this group were nocturnal and insectivorous. Morphologically they were very much similar to monkeys. Their head could be turned at 180°. So they could see backwards. The face and eyes were very much identical to lemurs (Fig. 6·2).

Most of the tarsiers died in the Eocene period, but later on about 40 million years ago their descendants took diversion. In the beginning of Oligocene period, these descendants became the ancestors of Anthropoids having the characters – reduced nose, Stereoscopic eyes, grasping hands and feet with nails and toes.

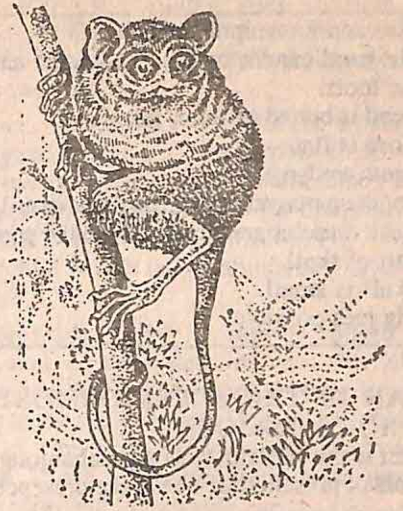


Fig. 6·2 Tarsius—the spectral tarsius

About 25 million years ago, in the beginning of Miocene period, the ancestors of apes and man started evolving on separate lines.

The family 'Pongidae' remained on the trees. They leaped on trees with four limbs.

The ancestors of man were grouped separately. This group was named as 'Hominidae'. Its members came down on the earth. Their hind limbs became longer and erect, hands were having opposite thumb.

Apes and Gorillas may be related to us but our body was built differently. We can compare the ape and man morphologically and can find some differences.

Table 6.1

Ape	Man
1. The forelimbs are very long which reach upto knee.	1. The forelimbs are short which reach upto thigh.
2. It stands with curved back and takes support of knee by putting hands over them.	2. It stands erect and so he is called as bipedal.
3. The feet can grasp like hands which helps it to balance on four limbs.	3. Feet cannot grasp. Feet are flat and form stable platform. This helps him to walk erectly.
4. The thumb is short.	4. The thumb is well-developed.
5. The thumb is near to other fingers of hands but is not movable like human thumb and cannot help in grasping the things.	5. The thumb is near the other fingers and is movable which helps in grasping the things.

Ape	Man
6. He cannot manipulate his hands.	6. He can manipulate his hands.
7. The hand cannot be used to handle and use the tools.	7. The hands can handle the things and can use the small tools with the help of hands.
8. Head is buried in heavy shoulders.	8. Head is erect with slender neck.
9. Nose is flat.	9. Nose is protruded.
10. Teeth are large.	10. Teeth are small.
11. Foramen magnum is directed backward.	11. Foramen magnum is directed downward.
12. Neck muscles are attached with the posterior part of skull.	12. Neck muscles are attached with the lower surface of skull.
13. Skull is small.	13. Skull is large.
14. Big toes possible.	14. Big toes not possible.

6.2 MAN IS THE SUPERIORMOST AND UNIQUE MAMMAL

Man is the superiormost animal among all the mammals of present time due to the presence of the following characters :

1. **Sterioscopic vision** : Man has a pair of eyes placed forward on the face. The image formed in both the eyes combined to make accurate judgement of the object.
2. **Large brain** : Man has large brain with large cerebrum etc., i.e, 1450 C.C., due to which man is more intelligent. He also have large size cerebellum which makes great co-ordination of muscles with other organs. No other mammals has such a large size brain so they are not intelligent.
3. **Learning and transmission capacity** : Man has the power to learn all those things which he visions and transmits them to other man. This process of transmission continues from generation to generation on this basis he accumulates the experiences and develops the culture. In early age man-made simple tools on the basis of which the Archaeologists called them as a tool-making animals.
4. **Less dependence on smell** : Man believes more on what he sees than what he smells and estimates.
5. **Opposable thumb** : Previously man had a thumb nearer to fingers in the some direction in which they are facing but now the thumb has taken a position opposite to other fingers in the hand-like other nearer relatives apes, monkeys etc., which helps in holding the object and bringing it in front of eyes and making accurate judgement.
6. **Foramen magnum** : Foramen magnum is an aperture on the hind most part of the skull through which the brain is attached with the spinal cord. It is situated just below the hind part of the skull or brain box while in other mammals it is situated in the hind part of the skull.
7. **Teeth** : Man possesses teeth in both the jaws. These teeth, are of four types which help in cutting, tearing and chewing the food. That is why, man it called as omnivorous animal having herbivorous and carnivorous teeth.

6.3 STRUCTURAL LIMITATIONS OF HUMAN BODY

Biped and erect posture : Man is a bipedal animal. He can stand erectly on his hind limbs. The vertebral column and broad pelvic girdle help him in maintaining erect posture but due to bipedal locomotion, he is more unstable as compared to quadrupedal animals like cows, buffaloes etc.

Colour sensitive retina : Though human eyes have rods and cones in the retina due to which he is colour sensitive but is unable to see in ultra violet and infra red rays light. KARL VON FRESCH in 1953 performed some experiments an honey bees and some flowers. Honey bee has the capacity to see in ultra violet light. Some flowers use ultra violet colour to attract bees.

Presence of salivary anylase : Man has well developed three pairs of salivary glands which secret saliva containing salivary anylase enzyme. This enzyme converts starch into complex sugars which are further digested by other digestive enzymes into soluble forms. This property is devoid in quadripedal animals and ruminants.

Antigravity postural muscles : Man has well-developed posterior muscles in him. Their muscles are antigravity in nature, their muscles help in lifting the limbs in opposite direction to gravitational force. The posterior muscles in the upper arm inforce limbs help in lifting, catching and handling the things in all the directions. In the same way, their muscles, present in the thing of hind limbs, help in fixing them with the pelvic girdle and lifting the body above the earth. Their muscles help in moving the hind limbs in all the directions. Through these muscles are also present in quadripedals but not well developed as in human beings.

Loss of tail and hair : Human beings have lost their tail during evolution. Man has also lost his long body hair. This hairless skin has made him prove to suffer with cold. A subcutaneous fatty layer has been evolved below the skin. This layer helps in maintaining the body temperature constant in normal conditions. This layer causes overheating the body during running, hunting or walking. To overcome this unfavourable conditions sweat glands have to be evolved. Thus by losing his fur and having a fat layer along with sweat glands. He could keep the body cool on the chase and warm when still.

Loss of well-developed sense of smell : During evolution, man has lost his keen sense of smell while the dog has well-developed sense of smell. It is because man has less developed olfactory lakes.

Location of testes : During evolution, testes in the make human beings have placed near urethra on its either side because they are directly connected with urethra through their respective vas deferens.

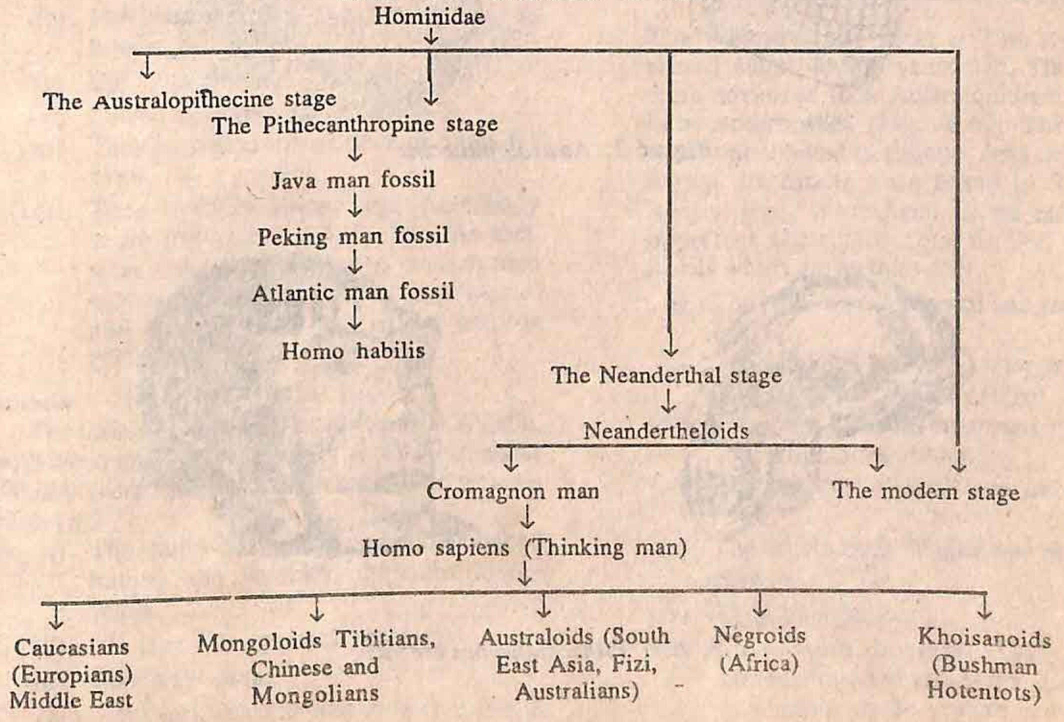
Short Intestine : During evolution, many digestive glands developed inside the coclomic cavity due to which the alimentary canal has been reduced in length as compared to quadripedals like cows and buffaloes He does not have microbial french in his alimentary canal like quadripedals.

Immovable and short pinna : Man has evolved neck muscles with the help of which he can move his head in any direction according to the requirement. He could lift his fore limbs. With these development, the external ear portion, i.e., Pinna has reduced his basal muscles which are short and immovable.

6.4 STAGES IN THE EVOLUTION OF MAN

Many fossils of man were found in different parts of the world which reveals that the evolution of man started from about 1.75 million years. Four stages have been recognised to have undergone in the evolution of the modern man (Table 6.2). These are - (i) Australopithecine stage (ii) Pithecanthropine stage. (iii) Neanderthal stage and (iv) Modern stage.

Table 6.2 Evolution of Man


Hominidae
The Australopithecine stage
The Pithecanthropine stage
Java man fossil
Peking man fossil
Atlantic man fossil
Homo habilis
The Neanderthal stage
Neandertheloids
Cromagnon man
The modern stage
Homo sapiens (Thinking man)
Caucasians (Europians) Middle East
Mongoloids Tibitians, Chinese and Mongolians
Australoids (South East Asia, Fizi, Australians)
Negroids (Africa)
Khoisanoids (Bushman Hotentots)

1. **The Australopithecine stage :** Australopithecine means 'The ape - man' or ' Man – apes' or 'Primitive men'. They had the characters of man and apes (Fig. 6·3).

Some main characters are as follows :

(*i*) They were about 120 centimetres in length.

(*ii*) Their brain was about 500 C.C.

(*iii*) Face was projecting forwardly.

(*iv*) Molar teeth were of large size but canines were short in size.

(*v*) Foramen magnum had shifted downwards.

(*vi*) Pelvic girdle was broad which helped in making erect posture, etc., *e.g.*, Zinjanthropus, Australo pithecus.

2. **The Pithecanthropine stage :**

The fossils of this stage are about 50,000 to 1,00,000 years ago. By studying the fossils of this stage, the main characters were studied which are as follows :

(*i*) The length of the body was about 150 cms.

(*ii*) The size of the brain was 1,000 C.C. so they were intelligent.

(*iii*) Molar teeth were having heavy ridges but in reduced form.

(*iv*) They were carnivorous.

e.g., Java man (Pithecanthropus erectus), Peking man, Atlantic man and Homo-hobilis (Tool maker).

Java man fossils (Fig. 6.4) were discovered in Java, China and Africa. They were having the following main characters :

(*i*) They were having jaw bones with several teeth.

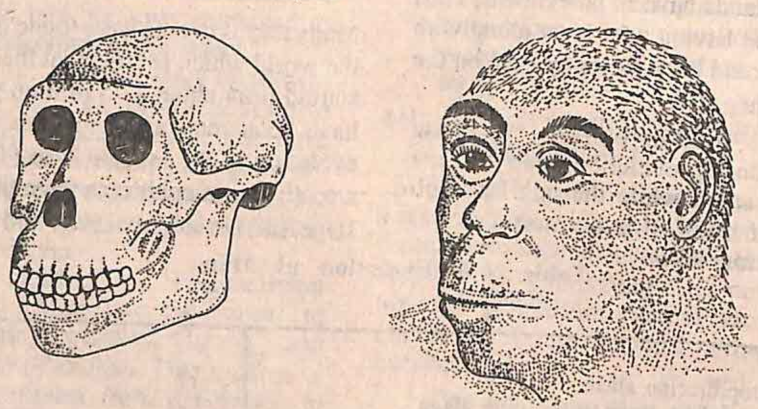


Fig. 6·3. Australopithecine

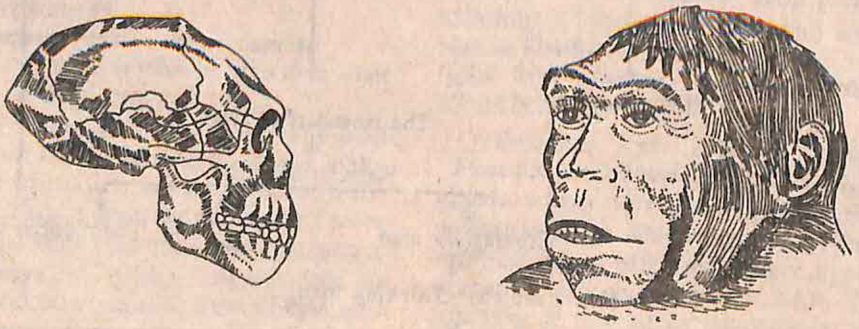


Fig. 6·4. Pithecanthropus erectus

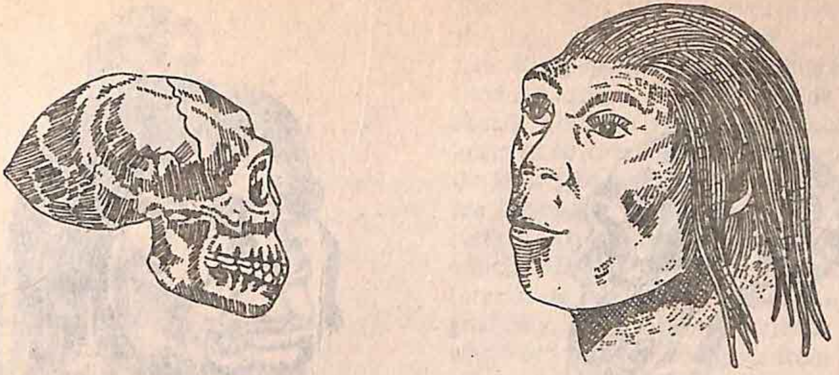


Fig. 6.5 Peking man

- (*ii*) Skull was too big.
- (*iii*) There was a thigh bone.
- (*iv*) The forehead was reduced and having prominent brow ridges.
- (*v*) Jaws were heavy and projecting forward.
- (*vi*) Chin was almost absent.
- (*vii*) The brain was of 900 C.C. capacity.

Peking man : The main characters of such fossils (Fig. 20.5) are as follows :

- (*i*) They were found near Peking (China).
- (*ii*) They lived in caves.
- (*iii*) Skull was thick with the capacity 1075 C.C.
- (*iv*) Forehead was low and is very near to brows.
- (*v*) Chin was absent.
- (*vi*) Canine teeth were large.
- (*vii*) They increased the number of hours for work.
- (*viii*) They lived in caves, kept their body warm and controlled the fire. As they were very much similar to modern man so they were put under the group 'Home' and were named as 'Homo erectus pekinensis'.

Atlantic man (*Ternifine man*) :

The fossils of such type were found in Algeria, Casabianca and Moracco. They were alive about 6,00,000 years ago. Their main characters were as follows :

- (*i*) The skull was rounded and dome-shaped having the foramen magnum downwards.
- (*ii*) The jaws were heavy and projected.
- (*iii*) Chin was absent.

They were very much similar to Java man and Peking man but appeared to be more advanced. They also started making caves with the help of Pabbles.

Homo habilis (*Tool maker*) : These fossils were discovered in 1962, 63 and 64. They were very much similar to Java man and Peking man. They started to make tools. They were having the following characters :

- (*i*) They were from 110 to 140 cms in height.
- (*ii*) They walked erectly.
- (*iii*) The skull capacity was about 700 C.C.
- (*iv*) Teeth were more similar to modern man.

3. **The Neanderthal stage :** This stage was started about 40,000 years ago. They were more advanced than Australopithecines and Pithecanthropines (Fig. 6.6). They were widely distributed in Europe, Asia and North Africa. Its fossils were found in Southern Russia, Iraq, West Asia, China etc. Some important characters were studied in their fossils which are as follows :
   - (*i*) The skull was depressed and projecting behind.
   - (*ii*) The forehead was short, sloping, broad and flat with heavy bow ridges.
   - (*iii*) The lower jaw was depressed and so the chin was almost absent.
   - (*iv*) The capacity of skull was about 1450 C.C.
   - (*v*) The whole body height was about 150 cms.
   - (*vi*) They made tools.
   - (*vii*) They were hunters. They hunted animals for food and skins. They were very similar to the modern man.

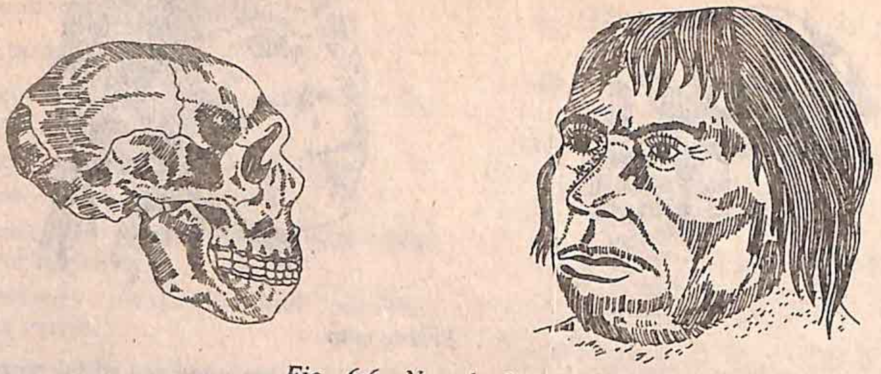


Fig. 6·6. Neanderthal man

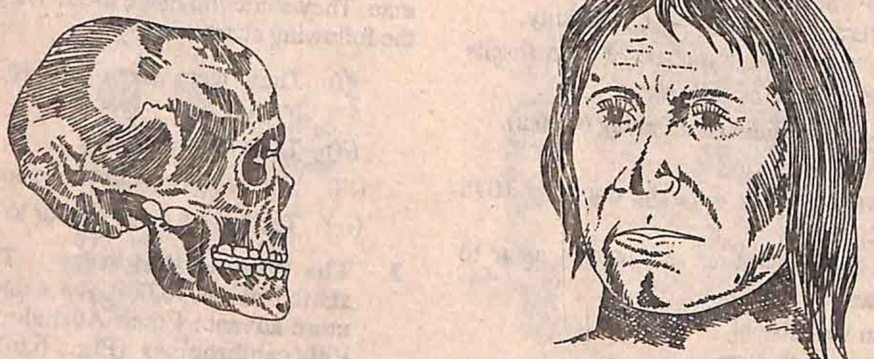


Fig. 6·7. Cro-Magnon

4. **The Modern Stage** : No doubt modern man was the modified form of Neanderthal. They had much similarities but Neanderthal was not modified directly into modern man. There was an intermediate stage also which was named as 'Neanderthaloid'. Their origin was about 35,000 years ago. The successors were known as 'Cro-Magnon Men'. They belonged the species 'Homo Sapiens'. They were our real and direct ancestors. They were found in Europe. Their fossils were found in a rock shelter at Cro-Magnon in France so they were named as Cro-Magnon man (Fig 20·7). Their main characters are as follows :

(*i*) They were about 180 cms in height.
(*ii*) Skull capacity was about 1660 C.C.
(*iii*) Face was broad.
(*iv*) The forehead was rounded without brow ridge.
(*v*) Jaws were thick broad and strong.
(*vi*) Chin was narrow but prominent.
(*vii*) Their nose was narrow.
(*viii*) They could stand erect on their feet.
(*ix*) They were swift movers.
(*x*) They were hunters, cave-maker and carnivorous.
(*xi*) They were tool-maker and were very good artists.

Modern Man : The present Homo-Sapiens have been living for about 25,000 years ago. It includes all the existing races. In the course of time, Homo Sapiens (Fig. 6.8) acquired the following evolutionary changes :

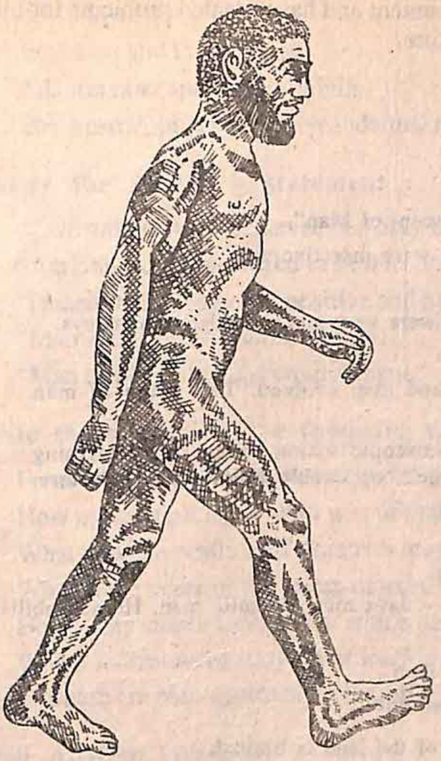


Fig. 6·8. Homo Sapiens Modern Man

- *(i)* They could stand erectly.
- *(ii)* The head is at top having two eyes, nose, chin and mouth.
- *(iii)* The limbs are erect. The forelimbs are shorter than the hind limbs or legs.
- *(iv)* Skull is much enlarged with well-developed cerebrum due to which the intelligence increased.
- *(v)* The forehead is flat with much reduced brow ridges.
- *(vi)* Snout has totally disappeared.
- *(vii)* The chin is narrow and prominent.
- *(viii)* Tongue is developed for speech.
- *(ix)* They are hunter and meat eaters.
- *(x)* They knew producing fire, its uses and the method of protection from it.

6.5 ROLE OF MAN IN EXPLOITING THE ENVIRONMENT : According to Charles Darwin the population of animals and man increases arithmetically while the food increases geometrically. As the human population increases it requires more basic needs *i.e.,* food, clothing and shelter. The land is limited. So, on increasing the population man started to wipe of the forests to get the land for residential and industrial purposes. He utilized the agricultural land also in residential and industrial purposes which resulted the deficiency of food production. It was one of the crisis. During a decade *i.e.,* from 1959 to 1969 nearly 1·9 million hectares of forests have been wiped off. On cutting the forests the rainfall has been affected. The deserts are increasing day-by-day. The temperature on earth is also increasing with the decrease of rainfall which affected the vegetation. On cutting the forests the wild animals are going to disappear gradually. There are some varieties of wild animals which are going to disappear from the earth. They are not only disappearing but also disturbing the food chain and food web.

By increasing the population, the pollution of air, water, noise and soil have been increased which have affected adversely on human health. Many household wastes, industrial wastes and agricultural wastes, insecticides, pesticides etc., are polluting the water day-by-day which are causing the various types of diseases increasing day-by-day.

The population, in cities, are increasing more rapidly than that of the villages. Population in cities per capita density is increasing and the sound pollution is also increasing day-by-day.

For meeting out the increasing need of food, man is trying to increase the yield per hectare for which he is using chemical fertilizers. These fertilizers, no doubt, increase the yield but loses the natural fertility of the soil and becomes the originator of several diseases.

According to Darwin's theory, struggle for existence can be seen due to over population. People start fighting for their existence and surpassing the others. Enemity starts among themselves. They use different types of weapons. Chemical bombs, bacteria bombs, atom bombs etc., are replacing to arrows, pierces and other ammunitions which are not only fatal for the present population but also for the forth coming progeny. These bombs, radio-active substances and chemicals are also polluting air, water and soil.

More factories, more vehicles and more colonies are producing more carbon dioxide and carbon monoxide, sulphur dioxide, Ammonia and various other harmful and waste material which are responsible for air and water pollution.

During 1960 the percentage of CO_2 have increased upto 14% due to which the atmospheric temperature have increased. Thus man has exploited the environment. He is responsible for ecological and non-renewable sources crisis. Biotic and abiotic factors are interdependent and intimately linked to each other so the crisis in one factors will certainly lead to the crisis in other factors. Thus the destructive activities of man have disturbed his own environment and have created problems for himself for future.

Summary

1. T.H. Huxley wrote a book "Man's Place in Nature".
2. In 1871 Charles Darwin also wrote a book "The Descent of Man".
3. Among mammals free shrews took place first. They were insectivorous.
4. Lemurs descended from shrews.
5. The group Tarsioids evolved from Lemuroids. They were very much similar to monkeys. Anthropoids originated about 40 million years ago.
6. About 25 million years ago the ancestors of ape and man evolved. The group of man called Homonidae.
7. Man is the highest animal as he possesses the stereoscopic vision, large brain, learning and transmission capacity. Less dependence on smell, opposable thumb, erect posture, Foramen magnum and teeth.
8. **Stages in the evolution of man :**

   Homonidae – (1) The Australopithecine stage
   (2) The Pithacanthropine stage – Java man, Atlantic man, Homo habilis.
   (3) The Neanderthal stage
   (4) The modern stage – modern man.

The Role of Man is exploiting the environment :

The human population is increasing day-by-day. The area of the land is limited.

Man is utilizing the land in establishing the industries and constructing houses. So he is creating imbalance between population and food.

Man is polluting air, water, soil and environment. People are migrating from rural areas to urban areas. So the population per capita density is increasing day-by-day in urban areas.

People are using chemical fertilizers for increasing more yield.

Due to over population, there is struggle for existence in which people are using atom bomb, bacterial bomb, chemical bomb and other fatal weapons for their victory. These things are not only decreasing the population but also polluting air, water and soil along with several types of diseases.

Excess number of industries and population produce carbon dioxide in excess amount which is a heavier gas and is producing excess of heat on earth.

QUESTIONS

1. **Define the following :**
   (*i*) Fossil (*ii*) Agriculture (*iii*) Deforestation
2. **Write 'T' or 'F' against each statement for true or false respectively :**
   (*i*) Thumb helps in grasping the things.
   (*ii*) Neck was present in the ape.
   (*iii*) Presence of claws interfere and reduce the grasping power of hand.
   (*iv*) T.H. Huxley made scientific attempt to explain the evolution of man.
   (*v*) Cerebrum was too much enlarged in apes as well as in man.
   (*vi*) The primitive man was the carnivorous animal.
   (*vii*) Snout was present in the apes but has totally disappeared in modern man.

3. Give the points of difference between the following :

- (*i*) Ape and man
- (*ii*) Java man and Peking man.
- (*iii*) Atlantic man and Homo-habilis.
- (*iv*) The Australopithecus and Neanderthal man.

4. Justify the following statement :

1. "Civilization could be developed only by the development of articulated speech."
2. "Agriculture is considered to be a technology that organised people."
3. "Present technology has positive and negative aspects both."
4. "Man is the superiormost mammal."
5. "Man has exploited the environment."

5. Write the answer of the following either in one word or in one sentence :

- (*i*) From which stage Man started to make tools ?
- (*ii*) How much capacity of skull was of man in Neanderthal stage ?
- (*iii*) What was the position of Foramen magnum in the primitive man ?
- (*iv*) What is the name of the group of man's ancestors ?
- (*v*) How many stages recognised, which have undergone in the evolution of man ?
- (*vi*) Which indicates the increase of intelligence in the evolutionary man ?
- (*vii*) In which era man appeared on the earth ?

6. Long Answer Questions :

- (*i*) Write the main features of modern man.
- (*ii*) In what aspects the man is responsible for ecological crisis ?
- (*iii*) What are those characters which are responsible for taking down the man from the trees to the ground ?
- (*iv*) What is the role of Charles Darwin in the evolution of man ?

7. Give reasons for the following :

- (*i*) Extinction of tail was responsible for earth dweller from arborial nature.
- (*ii*) Forelimbs are shorter than the hindlimbs in man.
- (*iii*) Bipedal mode of locomotion is more unstable in comparison to Quadripedal mode of locomotion.
- (*iv*) Man is called Omnivorous.
- (*v*) Foramen magnum is deviated downwards from the posterior side.

□□

UNIT V

WORLD OF WORK

CHAPTER 7

SCIENCE, TECHNOLOGY AND MAN

LEARNING OBJECTIVES :

At the completion of this Chapter, you should be able to answer—

1. Why and how did the man try to invent ?
2. Invention of Wheel. The main reasons behind it and the utility of wheels in various fields of life.
3. Invention of communication like telephone, wireless, radio, television.
4. Invention of Medicines reduced the death rate and causes increase of population.
5. Technology changes our lives.
6. Factors responsible for rapid growth in technology.
7. Technology and Science are interdependent.
8. Need of energy.
9. Types of energy invented in different times.
10. How fast does technology develop and how soon it is adopted ?
11. Interrelationship between Science and Technology.
12. Application of Technology and Scientific principles – their explanations by taking examples of Davy's lamp, electric bulb, invention of Printing Press and means of transport and communications.
13. New technology invents new needs – its explanation with suitable examples.
14. Science and Technology are the two phases of a coin.
15. Proper use of technology.

INTRODUCTION

In early stages of civilization, man tried to fulfil his needs. He tamed the animals and plants. He made use of fire. He made caves. He tried to manage his food for future. He then made many types of ammunitions for hunting and keeping safe from wild animals and enemies. Since the evolution of modern man till today man is busy in the improvement of his living. In this work his brain is acting as the tool with the help of which he is inventing and improving his ways of life. In all these activities science is playing an important role. With the knowledge of science he is inventing new things day-by-day. Now we see that science is playing an important role in every stage of life. It can be explained with the help of some examples.

7.1 MOTION AS MANIFESTATION OF WORK :

Invention of wheel : By the rapid change in the civilization, man tried to make his life easy and quick for which he made wheel. In the ancient time, man was the only source of sending message and luggage from one place to another. He took not only days but months together in sending messages. The duration of sending message depended on distance. He could make it easy when he started taming the animals. Birds and dogs were treated as the messengers. Horses, camels and other animals were tamed for loading the luggage from one place to another. They reduced the time but still it was sufficient when messenger used to reach from one place to another by riding on pet animals. Then man made a wheel, which proved very helpful. First of all it was used in the carts which were pulled by man and animals then in the cars, buses, trains, aeroplanes etc. It could reduce the time in transportation and in carrying heavy loads at a time. During the last three decades, a tremendous change has come in the field of transport and communication. Now supersonic planes, rockets through which one can move in the space have come into existence. Man has travelled to the Moon. It could be possible only by the advancement of science. It had become possible only by the development in science and advancement of technology.

Invention of Communication : In ancient time the source of communication was only the messenger but now science has developed the means of communication also. With the help of telephone or wireless the person can talk from one place to a distant place on earth. The information of the events of a country can be received in another country. Newspapers, radio, television etc., are some of the common sources of communication.

Invention of Medicines : In older times, people used to die by several diseases like plague, cholera, small pox etc., but with the help of science, vaccine and several medicines were invented and such fatal diseases could be overcome with the result of that, death rate reduced and the human population increased.

IMPACT OF TECHNOLOGY ON PHYSICAL, SOCIAL AND CULTURAL ENVIRONMENT :

Technology the fruit of science, is the practical use of science for designing various types of devices. The origin of technology is not a new. It has developed since prehistoric period upto about 5000 years ago. Each technology has been a landmark of the development of civilization. Discovery and use of fire, preparation and use of weapons, modification according to need and for their age, domestication of wild animals, their use in transport and agriculture are some of the main steps which reflect on the various stages of the development of civilization and the development of science too. This whole description reflects on two main points – (1) *Each new technology changes the way of life and the ability to do things in human beings.* (2) *Each technology develops the rate of development in the existing erq.* These points can be explained with the help of an example of agriculture.

Processing and preparation of food by man and other living organisms :

Food is one of the essential needs of every living organism. Nearly ten thousand years ago man was meat-eater. He used to eat flesh of wild hunted animals. Then after the discovery of fire he started eating roasted meat. Then he made caves and thought to store some food for future. He discovered that it was possible to cultivate certain plants so that he may get the food easily and regularly. So he started agriculture. The technology of agriculture was thus born and improved. The early or primitive man used primitive tools and methods and started growing wheat. It compelled the man to stay at one place, grow the seeds on the land reap them after maturation and store the grain. For that storing and staying purpose, he made shelter. As we know, agriculture requires labour for which he tamed wild animals and trained them. The use of animals like horses, bullocks, camels, etc., improved the method of agriculture and increased in the output. He, then, knew that various methods of drying the grains in the hot sun and protected them from insects by using Babul, Neem and other plants. The improvement in the methods of agriculture shows the improvement in the technology of agriculture.

The improvement of agriculture also made clear to man that he can manipulate the nature according to his need and wish. So he started growing plants for specific purpose like food grains, vegetables, fodder and other medicinal points.

Wild seeds and wild animals before cultivation and domestication were not the resources but after domestication they became resources. These conversion could be possible only with the use and help of technology. *Thus technology can be defined as the method of converting a non-resource into a resource.* In agriculture, the resources are seeds, water, soil and energy (animals).

In the same way, animal husbandry is a technology where the resources are cattle, poultry and other tamed animals.

Technology is the main source of the improvement of human society. By the use of technology in various spheres of life man had leisure time to think upon his status for which he developed new ideas for his better status. In this way new technology develops.

7.2 FACTORS RESPONSIBLE FOR RAPID GROWTH IN TECHNOLOGY :

The rapid growth in technology depends upon certain factors which are as follows :

(*i*) The case of working, (*ii*) The availability of raw materials of energy, and (*iii*) Economy.

First of all, man felt some need of any particular thing, say food for himself. He found the food by applying so many ways and means and then he improved the methods for keeping safe the grains and utilized in future. Thus he made attempts to convert these new resources so that new technologies are developed.

Meaning and application :

Evolution of Technology and Human Society : In early time man used stone and wood in the preparation of weapons because they were adequately available in the nature. These materials were not everlasting moreover the knowledge of using stone and wood in such forms could reach the people living at far distant countries gradually. So they use stone weapons in different times. Man was also busy in discovering some other alternative of stone and wood. The main reason was that the weapons made by stone were heavy and less durable. Different types of tools and weapons of that time are shown in *Fig. 7·1.*

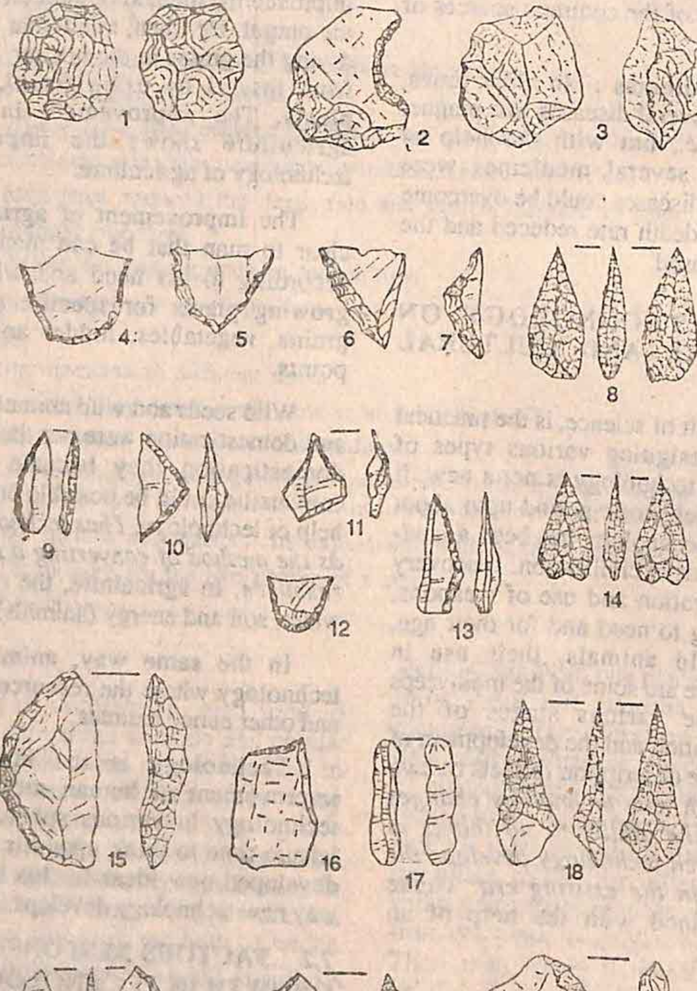


Fig. 7·1 Stone Age tools and weapons

1 and 3, prepared cores; 2, hollow scraper ; 4-6 and 12, tranverse arrow-heads; 7, 9, 15, 19 and 20, lunates; 8, 14 and 18, bifacial points; 10, triangle; 11, borer; 13, trimmed point; 16, burin; 17, blade; 21, convex scraper made on a flake struck from a prepared core

Then copper was discovered which was easily available and could be melted at low temperature. It was used in making utensils and weapons. The discoveries in science and technology continued with the help of which the strength and persistancy of copper was increased by mixing some other metals into it. The alloy was bronze. So bronze took place of copper. In this way copper age turned into bronze age. Bronze was seemed to be costlier and limited in nature. Therefore, discovery was made to replace bronze. Later on iron was discovered which was in abundance, easily extracted, easily melted and could replace bronze. All these ages *i.e.*, copper age, bronze age and iron age reveal the importance of metal and material in the history of man. Discovery of gun-powder and steam engine has been of great importance in human life. They all are made by iron.

7.3 NEED OF ENERGY : It was realised that energy get the top place in all the requirements of man. It is needed in all sorts of work. This need of energy is multiplied with the increase of needs. So man paid attention towards the source and use of energy. In early age, muscular energy was used in all types of work but when he tamed the animals like horse, bullocks, camels, elephants etc., he utilized their energy in transport, hunting and agriculture. This type of energy was also limited. So he discovered another source of energy.

Man learnt to tame the air and utilized the same in the form of energy. He utilized the wind energy in sailing the boat on water. He realised that the direction of wind cannot be controlled. So a skilful use of a set of sails and a rudder is necessary in order to steer a sailboat. Air energy is also utilized in several ways like windmill. Man did not stop to search the source of energy. He searched water as a source of energy. Thus natural non-resources were converted into natural resources. Thus *technology involves the application of science, its laws and principles in every day of life. That is why technology is also called as applied science.* The new discovery in science gives advancement in technology.

Thus, the source of energy were firewood, wind and water. Later, coal was discovered which became one of the most important energy resources. On seeing its utility, it is called as Black Diamond. It is used in railway engines, factories and also in producing thermal power.

Later the petroleum and natural gas were discovered which were used as the sources of energy. These are more convenient and efficient than coal. Now, the electricity has already been discovered. So it is utilised in various forms in human life. Now-a-days we are using it in almost all the spheres of life.

The latest source of energy is atoms. Atomic energy gives us an almost unlimited resource.

All the major discoveries in science changed and advanced the technology which changes the development of societies in the whole world.

As it is already discussed that technology depends on scientific discoveries. In the same way, application of technology also leads to newer scientific discoveries. For example, steam engine was invented by James Watt. His success in making the engine compelled his colleagues to seek theories linking to heat and power. Many questions were raised regarding heat and power which were discussed separately. The branch of science related to it is called as **Thermodynamics.**

The discovery of Telescope is also an example in the advancement of science. It was invented by the Dutch but was used by Galileo of Italy as scientific tool to study about the starts, satellites and other things present at the sky. The branch of science which deals with the study of the sky is called as **Astronomy.**

In Rockets liquid fuels are used. Rockets were discovered about 50-60 years ago by Goddard in U.S.A. and Von Braunn in Germany. In Second World War, Germany used rockets which can be assumed the beginning of the space age. Today we have rockets, through which, it can be launched in space, to other planets and galaxies. In 1969 Neil Armstrong and Edwin Aldrin of U.S.A. reached on the Moon, returned by carrying rocks and soil. Thus the study of moon through telescope was transformed into the study of Moon through microscope which took about 360 years.

How fast does technology develop and How soon is it adopted ?

The Table 21·1 given here reveals the development of technology during 3000 years upto 1800 A.D. It clearly indicates that the technology developed more faster during 1500 to 1800 A.D. Its main reason is the development of science methodically. Before 1500 A.D. the approach was through trial or hit approach which was not on scientific base. This type of approach is called as empirical approach. In fact the ideas were not clear and scientific. Scientific principles were not clear due to lack of practical efforts. The development of science was really started from 11th century when some scientists tried to explain the scientific principles through practical. Alhazen in 11th century, Roger Bacon in 13th century, Francis

Bacon, Copernicus, Galileo in 16th to 17th century and other scientists were some of the scientists who contributed a lot to science and technology. Now the technology in every branch of life, developed on the basis of scientific, logical, systematic and methodical basis and not only on the basis of empirical attempts.

7.4 INTERRELATIONSHIP BETWEEN SCIENCE AND TECHNOLOGY : As the development of science took place, its application in various branches of life took place which is called as the technology. So the relationship between science and technology became more strong. In 19th century, the technological inventions increased vigorously which cleared the scientific principles. Table 21·2 throws some light on the relation of technology and the industrial relations (1800 – 1900).

Application of Technology and Scientific principles : When the scientific principles became clear, they are employed in the daily life with the help of technology and thus the life became easy and smooth. One scientific principle could help in various fields of life by using it in different techniques. It can be explained with the help of few examples :

Davy invented a safety lamp which was specially meant for mines' workers. It was for light purpose but was without fear for fire. It was prepared on the principle of *heat conduction* ; smoke escapement and transmission of light. Thus one safety lamp could be prepared by using many scientific principles.

Electric bulbs, electric generator etc., are also prepared on the basis of the principles of light, electricity and heat conduction.

When the new sources of energy were invented, several new industries were set up with the application of scientific principles and technology. It can be explained by one example of textile industry.

In the older days the weavers used to weave the cloth by their own hands. One weaver can weave few metres of cloth in a day for which less amount of cotton is required. The demand was also limited even then anyhow the demand was met out. But with the use of electric power a mill could be set up which can produce thousands of metres cloth in a day for which it requires a large amount of cotton fibres. So the cotton was grown in large quantity. Thus a textile mill could satisfy the demand of the present human society more over the mill cloth was superior, fine and cheaper than that of weaver. This was happened in 18th and 19th century, when Europe saw it during industrial revolution. This all could be possible by the application of scientific principles and technology. Raw materials do not fetch a high price. When the raw material is modified into a finished product its price becomes double. It can be explained with the help of the following example:

Suppose the cost of wheat in the market is 3 rupees per Kg. When it is converted into Bread, it is sold at double price in the market.

In the same way iron ore is found in India in abundance which is very cheap but when it is refined and is converted into steel its cost becomes double or more than that. So we should not sell the ore to other countries. We should establish refineries and industries to manufacture various valuable articles. In all such work technology and scientific principle will be utilised.

In new age, several new inventions were made in every field of life. For instance, steam is utilised as a source of power with the help of it railway engines and ship engines are driven in transport. In the same way, when the petrol was invented, it was used in driving the light engines. The Wright brothers used these engines to fly their planes in 1903.

Now-a-days several new things like stainless steel, plastic, nylon, various types of alloys of metals etc., are invented which are used in making various types of useful things. Several types of medicines have also been discovered which are used to curing the patients of various chronic and fatal diseases, which have reduced the death rate. Several diseases like malaria, small pox, influenza, tuberculosis etc., were fatal diseases but now they all have become curable. They all have become possible only by knowing the scientific principles and their applications in the form of technology.

Printing Press was discovered in 1448. Before that all the books were hand-written. In which too much time and energy was required moreover these books can not be prolonged for a long time. With the help of Printing Press, books are printed in large numbers of the same type and are available at low prices.

Telephone, Telegraph, Radio, Television and Newspapers are the various sources of communication at the present time which enable us to get all the news quickly. Before invention of these communication agencies, man power was the only source to send the message from one place to the other. It took much time to reach to the destination. Now-a-days the technology of communication has been so advanced that through satellite in space, the news of one country is relayed to all other countries of the world immediately. Table 7·3 can throw the light on the important advances done in the country during the past fifty years. You will find by looking into the Table 7·3 that the newly developed technology has no long existence and widely use while the earlier technology had long existence. For instance in the middle of 19th century, safety matches were discovered. It is still utilizing in producing fire. Now-a-days the gap period between the development of a technology and its adoption is very small. The factors of the quick adoption of technology than earlier age are –

(*i*) The fulfilment of the needs.
(*ii*) Method of operation is easy to understand and to operate.
(*iii*) Less expensive.
(*iv*) Quick availability of whole information about the technology.

The advancement of science has become so high that the pre-existing technology is replaced by another new ones.

Today, aeroplanes have become very popular as a means of transport than ships or road transport.

7.5 DEVELOPMENT OF NEW AND IMPROVED TECHNOLOGY:

As the science advances, new technology is invented with the result of that new needs are originated. It can be described with the help of an example which reflects the light on industrial needs and individual needs as well. Both influence the status of the society.

About 100 years ago, Arabian peninsula was very poor economically. When the petroleum was discovered, new technology of oil came into existence. Saudi Arabia, Kuwait and United Arab Emirates (U.A.E.) were suppose to be the richest countries for petroleum. Petroleum is used in various ways in human life. So it is called as Black Diamond. Therefore, these countries are supposed to be the richest countries in the world. Oil technology needed crude oil, long pipelines, refineries, energy, transport and labour for which a revolution occurred there. Roads, airports, harbours were needed to be constructed. Cement, iron, power, rocks, sand and labourers were immediately needed for their construction. Communication with the rest of the world has to be maintained. All these requirements could be made from other countries of the world. In this way, new science principles and new oil technology developed there.

Now to fulfil the requirements of oil industry, people from other nations started to reach there. They had their own culture, own needs and other requirements. So they started to live in their own way. The traditions, customs and behaviour of foreigners gave their reflection on the life of the original people of these countries, which changed the way of life, the society and the traditions of these countrymen. The needs and the preference changed. For instance they started to have their own vehicles, own residence, television, Refrigerator etc. They have less time for shopping so they purchased edible things for a week and kept them in refrigerator. For all these things, they required electric energy. To lead the luxurious life, they use cooler, room heater, heater, etc. Radio, Television, Video and other devices of entertainment have become popular.

These changes first took place in the urban areas, later on they are adopted by rural people. Now all these comforts have become the needs of daily life. More and more village houses are now made of cement and steel.

This above mentioned example also explains that oil technology originated several other technologies which changed the status of the society. The adoption of one technology creates the need for another.

One Technology creates need for another

It is clear that technology has grown fast in the last few years. It is also clear that technology comes in wide use slowly. It also uses raw material very fast which influences the others and creates the need for other technology so to say, **one technology creates the other new technology.** It can be illustrated by the following examples :

People of India wear cotton clothes. These clothes are made by cotton cloth prepared in India. In ancient time people used to weave cloth with their own hands. Their weaving speed was slow. So the cotton crop cultivated every year in particular fields was sufficient for the whole year. This hand-made cotton cloth was of rough quality. When the foreigners came in India, people saw their clothes and wanted to change their clothes quality. Moreover the requirement of cloth increased due to the increase of population. So textile mills were established. Each textile mill need huge quantity of cotton everyday. The whole yield of cotton of one year is sufficient for say six months.What will happen for the next six months? The mill will have to close it. The labourers will become idle for the six months. Mill owners will have to pay their salary and will stock the production for which, he will have to pay the rent of godowns. All these things will compel the owner to increase the cost of the cloth. So the mill and the workers remain busy round the year, the production of cotton will have to increase double or more than that which will require double land or more than that. The land is limited so the cotton will be grown on the land by replacing the other crops you know that one person wears one dress at a time which has long life. So he will not require the new clothes every day while he requires food every day and the requirement cannot be decreased. So on replacing the cash crop or cereal crop with the cotton crop, there will be immediate need of cereal which will have to either borrow from other countries or will have to utilize any other new device. So the farmers will have to be aware of future need for which they have to store the grains safely for future. Just to keep the grain safely they will have to utilize new storing technology and will have to make planning for future also.

Another example regarding science and technology can be given.

Trees provide us timber, fuel, resin, gum and other valuable things for us. Each tree takes several years to develop and to become a full grown tree. If you start cutting ten trees only per year and grow new ten trees per year, the number of the trees will remain the same but the new plants will not provide us as many useful things as the old ones give. Moreover they will take several years to attain full growth. Therefore, the net result will be delayed for several years. Let the several years are considered as equal to ten years, we can represent the whole status of the forest of cutting and replanting tree through a graph as shown in *Fig.* 7·2.

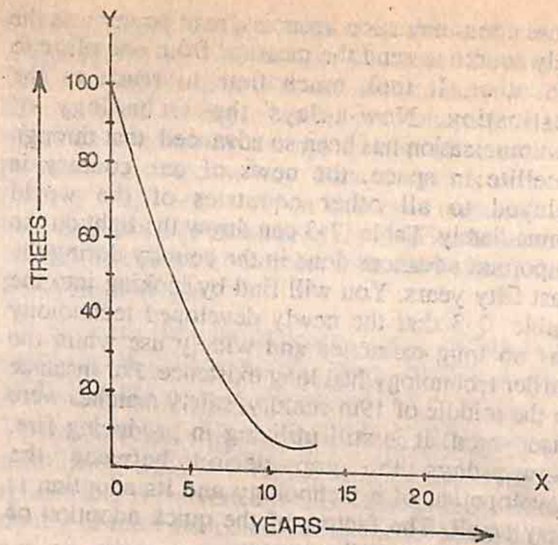


Fig. 7·2. A study of the status of the forest where trees are cut and replanted

Natural resources take time to build. Forests, petroleum are of the same type. Coal, oil, petroleum etc., all are formed inside the earth by the conversion of dead bodies of animals and plants in decomposition and decaying processes. These processes are very slow. Millions of years are required in the conversion of dead organic substances into petroleum, coal and oil. If we use them up in a couple of hundred years. They will not be prepared so quickly and the natural sources of energy will not be available to the forthcoming generation with the result of that there will arise the crisis of energy producing resources. Thus,

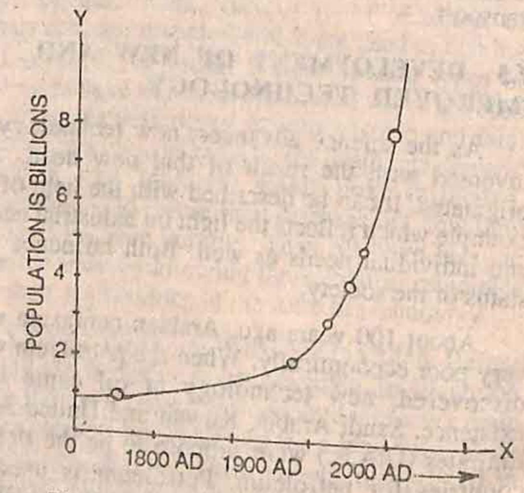


Fig. 7·3. A study of the status of the forest population where trees are cut and replanted production and consumption both are reverse to each other. Technology converts a non-resource into a resource but it also converts other resources into non-resources either early or late duration.

Growing cotton on vast area will give adverse effect on our food. Too much use water, manure and chemical fertilizers may give bumper crops for a few years but the land will become salty and unfertile for agriculture after few years. Therefore, the use of natural resources vigorously than the rate of their building causes harm. Thus natural resources will convert into non-renewable resources. It clearly indicates that science and technology are the two phases of a coin.

Make proper use of technology : As the science and technology developed very fast during the past 200 years but to know how to use technology properly will take a long time. It can be explained with the help of an example.

After Second World War *i.e.*, after 1945 there were new discoveries made in medicines due to which several fatal diseases like pneumonia, plague, tuberculosis, small pox, malaria, etc., were overcome. Infections could be controlled upto some extent. The birth of a child became safe and sure. Thus the death rate decreases while there was no check of birth rate which causes increase of population. In 1830 the world population was about one billion. It is estimated that within one hundred years it will become 8 billion. Such growth of any thing which becomes double of itself in a fixed time is called exponential. The graph in Fig. 7·2 will show the relation of time and growth. The over population will create so many problems like food, space for living, space for industries, pollution etc. These problems will compel the person to think over the solution for them it will cause the new inventions in science but some time it will become impossible to correct the problems.

Table 6.1

Development of Technology Between 1000 B.C. and 1800 A.D.

Period	*Technology*	*Societies Using it*
600 B.C	Rotating stones to grind corn	
350 B.C.	Cotton spinning into yarn	Indians, Greeks – for clothing
300 B.C.	Gears made of wood, pulleys and screws	Greeks, Romance – for lifting heavy loads.
100 B.C.	Screw press for fruits, iron wheel chariots	War efforts of Greeks, Cells.
300 - 500 A.D.	Alchemy, glass, water wheels, Silk	Arabs, Europeans, Chinese
	Threadmills	Greeks, Egyptians - lifting weights
	Paper	Chinese
	Astronomy	Greece, India (Ptolemy, Suryasiddhant)
500 -1000 A.D.	Boats, Magnet compass windmills	Vikings, Chinese, China, Persia
	Mathematics	India (Mahavira)
	Road maps and road building	Romans
	Astronomical calculation	India (Aryabhatta to Bhaskara)
1000 – 1250 A.D	Glass making factories	Italy
	Metallurgy	Europe

Period	*Technology*	*Societies Using it*
	Marble type for printing	China
1250-1500 A.D.	Handlooms and Machine looms	China
	Alchemy	India
	Mechanical clocks	Europe
	Printing press	Germany
	Cannons and fire weapons	China
1500-17000 A.D.	Land surveying using geometry	Europe
	Mineralogy	Germany (Agricola)
	Microbiology-discovery of Germs	Western Europe
	Dynamics, magnetism, electricity Analytic - geometry	Europe
	Microscope and its use	Holland
	Inductive logic	France (Descortes)
	Telescope and astronomy	Holland, Italy
	Gravitation theory, calculus	England (Newton)
	Steam engine	England
	Chemistry	England (Robert Boyle)
	Thermometers, electrostatic machine	Europe
1750-1800 A.D.	Spinning machines for cloth, lighthouse, bridges over water, vacuum pump, voltaic pile for electricity, Watt's steam engine, steam road carriage.	England, Europe

Table 6·2.

Technology and the Industrial Revolution (1800-1900)

Period	*Technology*	*Application*
1800-1805	Steam Boat	War and Communication
	Steam locomotives and railways	Transportation
1815	MC. Addam roads using stones and gutters	Roads Transportation
1825	Wire gauze lamp by Davy	Safety lamp for mines
	Meat preserved in tins	Storage of food
	Tunnel across the river Thames	Transportation
1830-1850	Wrought iron produced	Engineering buildings
	Water turbines	Engineering
	Vulcanised rubber	Transportation
	Invention of telegraphy	Communication
	Photography	Communication

Period	*Technology*	*Application*
	Portland Cement	Superior Building material
1850-1880	Synthetic dyestuff	Textile
	Artificial silk (Rayon)	Textile
	Production of steel	Industry, Building, Engineering
	Drilling for oil (Petroleum)	Fuel, war
	Electric generator	Engineering
	Electric Bulb	Engineering, Energy
	Steam turbine	Engineering transport
	Dynamite	Safe explosive, war
	Typewriter	Communication
1880-1900	Mass Production in Agriculture	Food needs
	Skyscrapers Built (High rise Buildings)	Easy construction
	Diesel Engine	Engineering Transport
	Petrol Engine	Engineering Transport
	Cinema Projectors	Communication

Table 6·3

Technological Advances in the 80-year period (1900 to date)
The Second Industrial Revolution

Period in Years	*Invention*	*Inventor/ Scientist*	*Name of the Country of Inventor*	*Year*
1900-1910	Quantum Theory	Max Planck	Germany	1900
	Engine powered airplane	Wright brothers		1903
	Diode Valve	John Fleming	England	1904
	Plastics made	Bakeland	Belgium/U.S.	1906
	Chemical treatment of diseases	Ehrlich		1907
	Bakelite	Leo Bakeland	Belgium/US	1908
	Motor cars	Ford		1908
1910-1920	Vacuum tube or valve for radio and wireless communication	Fleming	England	1904 & 1912
	Atomic number	Henry Moseley	England	1913
	Huge canal built (Panama)			1914
	Tank	Ernest Swinton	England	1914
	General theory of relativity	Albert Einstein	Switzerland	1915
	Proton	Rutherford	England	1919
	Electromagnetism	Hans Christian Oerstid	Denmark	1920
1920-1930	Broadcasting of Radio network			1922
	Television	John Logic Baird & others	Scotland	1925

Period in Years	Invention	Inventor/ Scientist	Name of the Country of Inventor	Year
	1st Rocket Built using liquid fuel	R.H. Goddard	U.S.	1926
	Electric shaver	Jacob Schick	U.S.	1928
	World's tallest Building in New York			1930
	Jet Engine	Frank Whittle	England	1930
1930-1940	Hydro Electric power by constructive dam	Boulder Dam		1936
	Gas turbine Engine	Whittle and Chain		1937
	Synthetic fibre Nylone made	Carothers		1939
	D.D.T. insecticide made	Muller		1940
	Platinum	G.T. Scaborg		1940
1940-1950	Anti Biotic drugs (Penicillin)	Fleming & Florey	U.K.	1942
	1st atomic chain reaction	Fermi & others		1942
	1st Atomic Bomb		U.S.A.	1945
	1st Electronic computer	J. Presper Eckert & John W. Mauchly	U.S.	1946
	Aircraft faster than sound.(supersonic)			1947
	Polaroid camera	Edwin Land	U.K.	1947
	Transistors			1947
1950 to-date	Atomic power plant for			1948
	Peaceful uses			1952
	Space Exploration	Sputnik	U.S.S.R.	1957
	Laser rays	Theodore Maiman	U.S.	1960
	Satellite Communication			1970s
	Bio Technology			1975
	Personal Computers			1980s.

SUMMARY

1. In the early stages of civilization, the life of man was very simple. Since the evolution of modern man till today, he is busy in improving his living. His brain is acting as the invention box. In all activities, science is playing an important role.
2. **Motion as Menifestation of Work**

   Invention of wheel proved very helpful. Man used it in all means of transport.
3. Science has developed the means of communication like telephone, wireless, radio, television etc.
4. Science has reduced the death rate by inventing new medicines, and vaccines against several fatal diseases.

Impact of Technology on Physical, Social and Cultural Environment:

5. Technology is the fruit of science.

Each technology changes the way of life and the ability to do things in human beings. Each technology develops the rate of development in the existing era. Thus, technology is the method of converting a non-resource into a resource.

6. Meaning and Application : Evolution of Technology and Human Society.

Man-made the tools and weapons of stone and wood but later on of metal.

Copper age, Bronze age and Iron age reveal the importance of metal and material in the history of man.

Technology involves the application of science, its laws and principles in everyday life. So technology is also called as the Applied Science.

All the major discoveries in Science changed and advanced the technology which changes the development of societies in the whole world.

7. Interrelationship between Science and Technology : Table 21·2 throws some light on it.

8. Application of Technology and Scientific Principles :

On clearing the Scientific principles, they were employed in daily life with the help of technology. He made Davy's safety lamp, electric bulb, generator, several types of machines, printing press etc.

9. Development of New and Improved Technology.

10. One Technology Creates need for Another : It can be explained by taking examples of natural resources of energy and renewable resources of energy.

11. We should make proper use of technology, we should use it only for peace and improvement and not in destructing purposes.

QUESTIONS

1. **Define the following :**

(*i*) Technology (*ii*) Natural resources (*iii*) Renewable resources

Long Type Questions

1. "Technology has converted non-resources into resources." Discuss this statement with the help of an example.

2. "Science and Technology are the two phases of a coin." Justify this statement.

3. What are those factors which are responsible for the rapid growth of technology ?

4. "Industries have influenced the man's life." How far do you agree with this statement ?

5. "Modern technology may convert resources into non-resources." Do you agree with this statement ? If yes, explain how, with the help of example.

6. "The use of new technology creates new need and vice-versa". Discuss this statement.

7. "Man should make proper use of technology." How far do you agree with this statement ?

8. Observe at Fig. 7·1.

(*a*) Write the number of trees at the end of 15 years, 25 years, 30 years and 40 years.

(*b*) What will be the consequences if we cut 10 trees per year but grow 20 new trees per year ?

(*c*) Explain in brief the result if we cut 20 trees per year and grow 10 new trees per year.

9. Write the means and ways of sloping down the curve which is shown in Fig. 7·2. Can it be brought down to a horizontal line at all ?

10. How has the energy become helpful in improving the civilization ?

11. Why was the Iron age discovered ?

12. Write the names of the inventors of the following :

(*i*) Plastic (*ii*) Tank (*iii*) Polaroid Camera (*iv*) Electronic Computer

(*v*) Gas turbine (*vi*) Jet engine

13. Fill in the blanks :

(*a*) Wild animals were not resource but become resource after ....

(*b*) ...., ... and .... are the basic needs of man.

(*c*) Man is using .... and .... as the main sources of energy.

(*d*) Goddard discovered ....

(*e*) Death rate is reduced due to .... inventions.

14. Match the following :

Column A	**Column B**
Diode Valve	Muller
Motor Car	Theodore Maiman
Rocket liquid fuel	R.H. Goddard
D.D.T.	Ford
Laser	John Fleming
Gas turbine engine	Whittle and Chain

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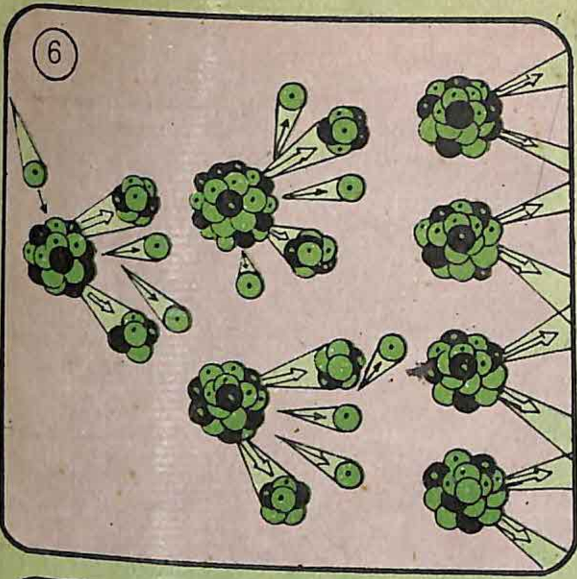

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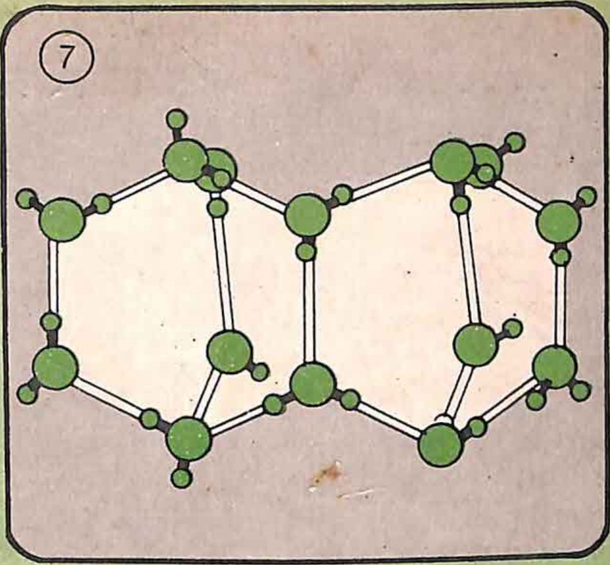

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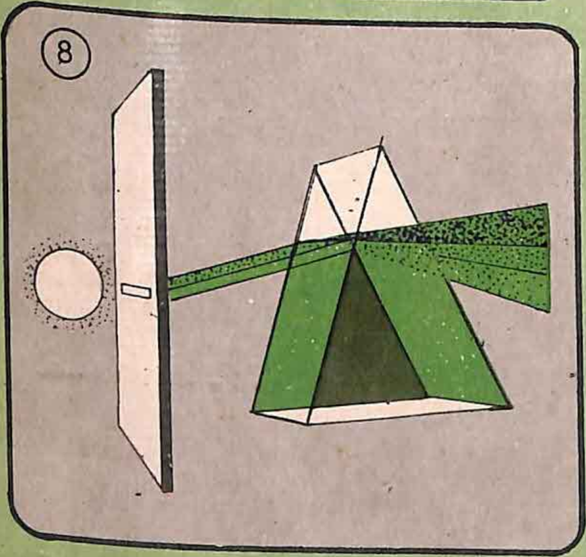

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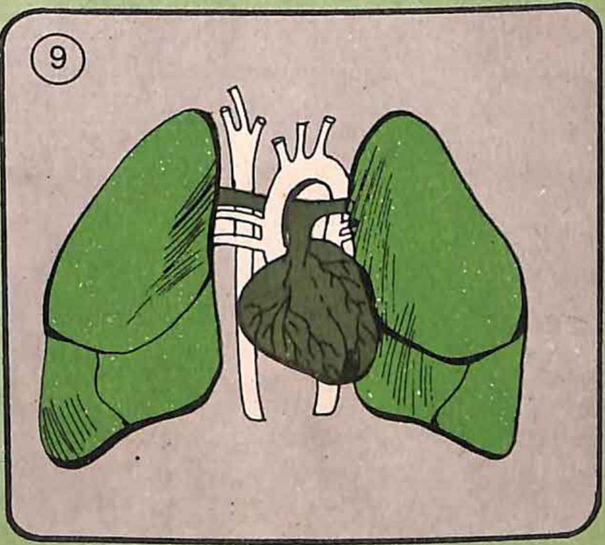

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